Neighbourhoods and children's social and cognitive development – pathways of effects

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Declaration

I, Anja Heilmann, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Background: The relevance of neighbourhoods for inequalities in children's development, while receiving increasing attention, is still debated. This PhD thesis aimed to examine whether children's place of residence influenced their social and cognitive development, and to test two specific pathways through which such place effects might operate. It was hypothesised that schools contribute to the variability in children's socio-emotional and cognitive outcomes across neighbourhoods, and further, that neighbourhood characteristics affect children via maternal psychological distress and parenting.

Methods: Participants were 7-year-old children and their mothers from the UK Millennium Cohort Study. Cross-classified multilevel models were run to simultaneously estimate the variability in the child outcomes between neighbourhoods and schools; and to examine potential mediating effects via maternal psychological distress and selected parenting behaviours.

Results: Most of the variability in children's socio-emotional difficulties across neighbourhoods and schools was explained by the clustering of children from similar socioeconomic backgrounds. However, for children's cognitive test performance, considerable variability between neighbourhoods and schools remained even after allowing for such compositional effects. Structural neighbourhood factors such as median household income were associated with cognitive outcomes, while neighbourhood social processes were related to children's socio-emotional development.

The data did not support a mediating role for maternal psychological distress in relation to teacher-reported socio-emotional difficulties or cognitive test performance. However, maternal psychological distress was on the pathway between social processes in the neighbourhood and socio-emotional difficulties reported by the mother. There was no evidence to suggest mediation via the examined parenting practices.

Conclusions: Children's experiences within their neighbourhoods and schools contribute to their social and cognitive development. Schools appear to be an important area for investment. However, given the fundamental role of families' individual circumstances, an integrated approach is needed which combines policies directed at schools and neighbourhoods with measures that support children and their families directly.

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List of abbreviations

ABI	Area Based Initiatives
BAS	British Ability Scales
CAPI	Computer Assisted Personal Interviewing
CDU	Census Dissemination Unit
CLS	Centre for Longitudinal Studies
DIC	Deviance Information Criterion
GCSE	General Certificate of Secondary Education
HCZ	Harlem Children's Zone
ICC	Intraclass Correlation Coefficient
ICE	Index of Concentration at the Extremes
IFS	Institute of Fiscal Studies
IMD	Index of Multiple Deprivation
LR test	Likelihood Ratio test
LSOA	Lower Layer Super Output Area
MCMC	Markov Chain Monte Carlo
MCS	Millennium Cohort Study
MSOA	Middle Layer Super Output Area
MTO	Moving To Opportunity
NI	Northern Ireland
NISRA	Northern Ireland Statistics & Research Agency
NS-SEC	National Statistics Socio-economic Classification
NVQ	National Vocational Qualification
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics
PCA	Principal Components Analysis
SD	Standard Deviation
SDQ	Strengths and Difficulties Questionnaire
SEN	Special Educational Needs
SEP	Socio-economic position
SES	Socio-economic status
VPC	Variance Partition Coefficient

Thesis structure

The thesis is structured as follows. Following an introduction to the topic in chapter one, chapter two provides a review of the relevant literature and justification for this research. Chapter three states the aims, objectives and research hypotheses of the thesis. Chapter four introduces the data source, the Millennium Cohort Study. Chapter five gives a general description of the statistical methods that were employed in the analyses, while analytical strategies and concrete model specifications are outlined at the beginning of the relevant results chapters. The results of the analyses pertaining to the three main research aims of the thesis are presented in chapters six to eight. Chapter nine outlines the key findings of this project and how they compare to previous research, as well as addressing the strengths and limitations of the present study. Chapter nine also includes recommendations for further research and discusses the policy implications of the present findings.

Chapter 1

Introduction

1 Introduction

Research has consistently demonstrated that children's early experiences are extremely important, influencing health and well-being over the entire life course. It is also known that these early experiences are socially graded in societies all over the world, even in the richest (Hertzman and Boyce, 2010). This means that children growing up in families which are poorer do worse in almost all aspects of their development compared to their better-off peers. In explaining these gradients, the focus has traditionally been on the family, and it is true that family background is a strong predictor of children's developmental outcomes. But, recognition has been growing that social inequalities in child development exist also between places. Consequently, the potential importance of neighbourhood contexts has received increasing attention, and over the past two decades publications on neighbourhoods and child development have been steadily increasing.

Context or composition?

Where a child grows up will influence their daily experiences, who they meet, the friendships they make, the friendships their parents make, where they go to school, the spaces they can use to play, and maybe even whether their parents are happy. Parents want their children to grow up in neighbourhoods that are clean and feel safe, where schools have a good reputation and where both parents and children can befriend other families and have a sense of belonging. But, given the large differences in housing costs between desirable and less desirable areas, most families are forced to make a compromise between where they would want to live and where they can afford to live.

This leads to one of the biggest challenges in neighbourhood research – the fact that place of residence is not random. Family characteristics not only influence children's lives but also *where* they live. It might be that neighbourhood effects are just compositional, that is, due to people selecting into neighbourhoods they can afford, or in other words that children in poorer neighbourhoods do worse because they tend to *be* poor. Neighbourhood research however assumes the existence of contextual effects influencing people over and above their individual circumstances, in which case being poor *and* living in a poor area would carry a double penalty. Studies on neighbourhoods usually attempt to account for possible selection bias by adjusting for multiple family level variables, and tend to find modest remaining effects that can be attributed to factors operating at the neighbourhood level.

But, it has also been argued that composition and context cannot be separated because people influence places and places influence people, and that over controlling for factors that might be on the pathway between neighbourhood characteristics and outcomes can lead to an underestimation of neighbourhood effects (Diez-Roux, 2000). These questions are complex, and are still debated among scientists. Some researchers have questioned whether focusing on neighbourhood effects is informative at all (Bauder, 2002; Cheshire, 2007; Slater, 2013). In his recent critique, Slater (2013) turned the premise on which neighbourhood research ultimately rests, namely that where people live affects their life chances, around by saying: *"Your life chances affect where you live"*.

These are fundamental considerations, which have important policy implications. For example, there is the question of whether money spent on area based initiatives is money spent well. Given that family background is such an important factor for child development, and given that only about half of all poor families live in the 20% most disadvantaged neighbourhoods (Joshi et al., 2000; Melhuish and Hall, 2007), it might be more effective to improve the financial situation for all families at the individual level, for example by redistributing wealth (for a debate, see Dorling et al., 2001).

Possible pathways

Why would their place of residence make a difference to children's lives? Several explanations have been proposed, and two of them have been explored within this thesis. One hypothesis is that maternal psychological well-being as well as parenting practices are influenced by aspects of the neighbourhood. Because of the known links between maternal mental health and children's socio emotional and cognitive development, it is possible that maternal mental health is a mediator between neighbourhood characteristics and these child outcomes. Another potential mechanism is via the school environment, assuming that the majority of children go to school locally, thus having choices limited by where they live.

This project is based on the secondary analysis of data from the UK Millennium Cohort Study (MCS). Being a nationally representative study which includes the whole range of neighbourhoods in the UK, as well as containing a wealth of information on family and child characteristics, the MCS is well situated to the study of neighbourhoods and child development. This PhD thesis aims to contribute to the field by investigating whether neighbourhood conditions contribute to inequalities in children's social and cognitive development in the UK, over and above their family background. The question is, does it matter where children grow up?

Chapter 2

Background and literature review

2 Background and literature review

This chapter outlines a theoretical ecological framework which constitutes the basis of a large body of literature on neighbourhoods and children's development. It then provides an overview of the relevant empirical research that has been published to date. The chapter ends with a synthesis and discussion of the main findings and pathways that emerged from the reviewed literature, thereby highlighting the limitations of past research and gaps in current knowledge.

2.1 Background

"Early Child Development" has been defined as the period from prenatal development to eight years of age, and includes physical, socio-emotional, and language-cognitive domains (Siddiqi, Irwin and Hertzman, 2007). It is important in two ways: first as a set of contemporary markers, and second as a sensitive period influencing life chances and lifelong trajectories of health (Siddiqi et al., 2007; Hertzman et al., 2010; Maggi et al., 2010; Marmot, 2010). This PhD project is concerned with the socio-emotional and cognitive domains of child development.

Children's externalising behavioural problems and cognitive skills are known to be interrelated (McCulloch et al., 2000; von Stumm et al., 2010), and both have been shown to be powerful predictors of later educational achievement as well as adult employment and social class (Deary et al., 2005; Heckman, Stixrud and Urzua, 2006; Heckman, 2008; Johnson, Brett and Deary, 2010; von Stumm et al., 2010; Cheng and Furnham, 2012). Further, children and adolescents exhibiting conduct problems are also more likely to have poorer mental health and relationship problems in adulthood, as well as being more likely to become involved in criminal activity (Simonoff et al., 2004; Fergusson, John Horwood and Ridder, 2005; Hodgins et al., 2008; Colman et al., 2009). Continuity into adulthood has also been demonstrated for internalising problems in childhood and adolescence, which are associated with mental health problems in adulthood such as depression and anxiety disorder (Colman et al., 2007; Moffitt et al., 2007; Reef et al., 2009). Therefore, giving every child the best start in life has been identified as paramount to achieving social justice (Marmot, 2010).

2.1.1 Social gradients in early child development in the UK

The Institute of Fiscal Studies (IFS) estimated that in 2010-2011, before housing costs, 2.3 million children in the UK were living in relative poverty, that is, their families lived on an income of less than 60% of the median of the population (Cribb, Joyce and Phillip, 2012). With the cuts in welfare spending introduced by the current government, these numbers are set to rise - the IFS predicts that by 2020, 3.3 million children will be living in poverty (Brewer, Browne and Joyce, 2011). At the same time, social mobility in the UK is among the lowest in Europe (OECD, 2010).

Recent analyses of data from the Millennium Cohort Study, the Avon Longitudinal Study of Parents and Children and the Longitudinal Study of Young People in England showed that in the UK, differences in cognitive development between children from rich and poor families are already manifest at age three, have widened by the age of five and grow even bigger during the primary and secondary school years (Goodman and Gregg, 2010; Kelly et al., 2011b). Given that cognitive as well as non-cognitive abilities in early childhood are associated with later achievement and employment, these social gradients mean that children growing up in poverty are starting their lives at a disadvantage that might lead to the accumulation of even more disadvantage over the life course.

Researchers and especially policymakers increasingly focus on parenting and the home environment to explain and target the existing inequalities in child development (Ermisch, 2008; Field, 2010). The presence of routines and structure, provision of learning opportunities and parental responsiveness are thought to be crucial for children's healthy development, and several studies have demonstrated that these aspects of the family environment indeed contribute to cognitive as well as behavioural outcomes (McCulloch and Joshi, 2001; Ermisch, 2008; Dearden, Sibieta and Sylva, 2011; Kelly et al., 2011b). While parenting and the home environment account for part of the socio-economic gradients in markers of early child development, there are however still substantial proportions of the differences in attainment and socio-emotional development between children from disadvantaged and affluent families that remain unexplained. Also, there is a danger that the focus on proximal factors such as parenting leads to victim-blaming, and to policies which place the responsibility for adverse child outcomes squarely at the door of the family. Theoretical frameworks that focus on the wider and more distal contexts in which children grow up and live may provide a more complete understanding of the processes involved in early child development.

2.1.2 An ecological model of early child development

The notion that children's development must be understood within the context of their environment was first made explicit by Urie Bronfenbrenner (1979), who has become a point of reference in most journal articles on neighbourhoods and child outcomes. According to Bronfenbrenner's ecological systems theory, human development takes place through interaction with the immediate environment within the family and the school, which in turn are influenced by the larger contexts of the neighbourhood and available social networks, and eventually the wealth, culture, and social politics of the broader society. Bronfenbrenner distinguishes between micro-, meso-, exo- and macrosystems, which he describes as a "set of nested structures" (Figure 2-1). His model emphasises the relationships and interdependence between overlapping environments that are geographically as well as socially defined (Bronfenbrenner, 1994).

The family, being the most proximal and intimate environment for a child, is thought of as a microsystem that shapes children's experience via factors such as intra-familial relationships, cultural practices, the home-learning environment, housing and the health status of family members. Family socio-economic position impacts on all of the above and contributes strongly to inequalities in children's health and well-being (Siddiqi et al., 2007; Maggi et al., 2010).

Neighbourhood or community contexts and social networks constitute exosystems which also influence processes at the microsystem level. The social organisation of a neighbourhood (e.g. social networks and support, norms, crime rates), the physical environment including green spaces, and the availability and accessibility of institutional resources such as schools, health care, transport and leisure facilities might all influence children's lives (Leventhal and Brooks-Gunn, 2000; Maggi et al., 2010).

Fundamental causes of early childhood inequalities are embedded within the socio-political context of the wider society – or macrosystem – via factors such as income distribution, employment patterns, and education and welfare policies. An important question is hereby to what degree children's upbringing is regarded a societal responsibility or a private matter (Morrow, 1999; Maggi et al., 2010).

A fifth parameter is historical time, or the chronosystem according to Bronfenbrenner, which takes into account changes in the characteristics of both the individual and their environment over time and over the life course.

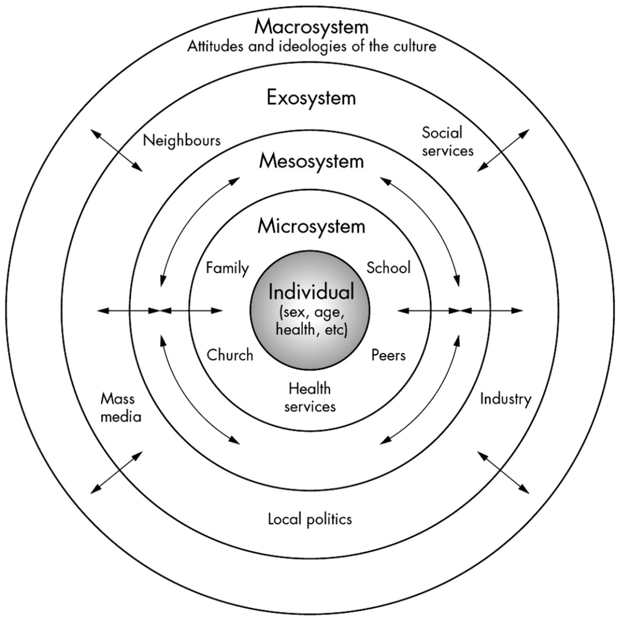

Figure 2-1 Bronfenbrenner's ecological theory of human development[1]

Biological embedding

Bronfenbrenner's emphasis on the importance of environmental influences is supported by advances in neuroscience and epigenetics, which have provided new insights into the effects of early environments on biological processes including gene expression. The term "biological embedding" was coined by Hertzman (1999) and relates to stable and long-term changes in bio-developmental states that are caused by experiences within social environments (Hertzman, 2012). Kuh et al. (2003) defined biological embedding as processes by which "extrinsic factors experienced at different life stages are inscribed into an individual's body functions or structures". Experiences can affect brain development, immune function and stress responses (Hertzman and Boyce, 2010). One of the mechanisms for biological embedding is via epigenetic processes, which are changes in gene expression that occur without changes in the underlying DNA sequence (Goldberg, Allis and Bernstein, 2007). These can be thought of as gene-by-environment interactions, where depending on environmental influences genes are activated or inhibited. For example, it has been proposed that such interactions play a role in the development of antisocial behaviour in children who were subjected to maltreatment (Moffitt, 2005).

[1] Source: McLaren, L. and Hawe, P. (2005): Ecological perspectives in health research.

Neighbourhoods are potentially important environments for children which can be safe or stressful, thus contributing to the biological embedding of experience.

Neighbourhoods and early experience

Recent interest in neighbourhood effects on individual-level outcomes has been spurred in the US through the work of Wilson (1987), who analysed the consequences of the increasing racial segregation and geographical concentration of poverty in American Inner City neighbourhoods. Since then, neighbourhood effects research has accumulated a large body of literature which aims to understand inequalities between places in health and well-being, including the development of children. Neighbourhoods might affect children in several ways, for example via the norms and social interactions they experience, via the safety of the spaces where they play, the quality of their schools or indirectly via the emotional well-being of their parents.

Qualitative neighbourhood research has related the often strongly felt consequences of neighbourhood disadvantage (Lupton, 2001; Popay et al., 2003). One example are the accounts of lone mothers from two disadvantaged areas in England, from which it becomes clear how the sense of fear and alienation caused by living in a place with which identification seems impossible can lead to withdrawal, isolation and depression (Popay et al., 2003). In contrast, quantitative studies on the associations between neighbourhood conditions and well-being have so far shown only modest effects. This might be due to the fact that the measurement of neighbourhood characteristics entails methodological challenges, one of the biggest being the problem of disentangling neighbourhood effects from outcomes that are due to the characteristics of individuals.

Massey (2001) argues that living in a poor neighbourhood exacerbates the disadvantages that arise from being poor, whereas living in an affluent neighbourhood reinforces the privileges that come with being born into a rich family. To quote:

> *"Clearly it is disadvantageous to live in a poor family and disadvantageous to live in a poor neighbourhood, but the total disadvantage of experiencing both at the same time is much greater than their simple sum." (Massey, 2001)*

It is however far from clear whether Massey's assertion is true, and despite the huge surge in publications on neighbourhood effects, there is still considerable controversy over whether these effects are important (Slater, 2013). The following literature review aims to shed light on the current state of knowledge.

2.2 Neighbourhood effects on child development and maternal mental health - review of previous research

Given that the nature of this project required the review of a vast amount of literature on related but different research questions (neighbourhood effects on children's socio-emotional and cognitive outcomes, and on maternal mental health), a full systematic review was beyond the scope of this thesis. Rather, the present review aims to provide a critical overview of the relevant empirical research that has been undertaken to date, without claiming completeness.

The structure of this section is as follows. It starts by presenting the findings and conclusions of two landmark publications which reviewed neighbourhood effects on children's behavioural and cognitive development: these are the reviews by Jencks and Mayer (1990) and Leventhal and Brooks-Gunn (2000). The paper by Leventhal and Brooks-Gunn (2000) is discussed in particular detail because it comprehensively covers the outcomes subject to this PhD project, up to the year 1998. Using the work by Leventhal and Brooks-Gunn (2000) as a starting point, the research published since 1998 is then reviewed under the following three subheadings:

1. Neighbourhoods and socio-emotional outcomes
2. Neighbourhoods and cognitive outcomes
3. Neighbourhood effects on maternal mental health and parenting.

The findings of studies which examined both socio-emotional and cognitive outcomes are reviewed separately under the relevant subheading.

Search strategy for systematic reviews and individual studies

Systematic reviews and individual studies were identified via searching PubMed. In addition, the reference lists of eligible studies were also screened. Considered was quantitative research that was published since 1998. Studies were included if they had analysed the association between at least one neighbourhood aspect and an outcome of interest. Outcomes of interest were measures of children's socio-emotional development including problem behaviour and delinquency, children's cognitive skills and educational attainment, maternal mental health and parenting practices. The upper age limit for "children" was 18 years. Not included in the present review are studies on children's physical health, physical activity and health behaviours such as smoking, and studies on child maltreatment. Also not included are studies which examined only school effects without any reference to neighbourhood contexts, however studies which estimated the variability in one of the child outcomes between neighbourhoods and schools were included.

Using these criteria, apart from the two landmark reviews the literature search retrieved one systematic review and 43 individual studies on socio-emotional development, 27 studies on cognitive development and 13 studies on maternal mental health and parenting practices.

The details of all individual studies (study design, outcome measures, study population, neighbourhood definition, neighbourhood aspects measured and key findings) that were retrieved for the present review are summarised in Tables 11.1 to 11.3, which can be found in Appendix I.

2.2.1 Landmark reviews

Jencks and Mayer (1990)

Jencks and Mayer (1990) were the first to review the evidence on the consequences of growing up in poor neighbourhoods. The authors looked at the effects of neighbourhood as well as school socio-economic status (SES) and ethnic composition for children's development and later life chances in the United States. Outcomes included educational attainment, cognitive skills, delinquency and teenage sexual behaviour. The review set out by formulating five theories regarding the mechanisms through which neighbourhoods might exert an influence on children's lives:

1. *Epidemic models* focus on peer influences, assuming that behaviour is contagious.
2. *Collective socialisation models* are about the presence of successful adults acting as role models for all children in the neighbourhood (not only their own), as well as being prepared to intervene if unruly behaviour occurs.
3. *Institutional models* postulate that children and youth are influenced by adults coming from outside the community to work in the neighbourhood, such as teachers and policemen. Schools in more affluent neighbourhoods might attract better teachers, while policemen might tend to treat youths more fairly within an overall safer environment.

4. *Relative deprivation models* assume that children and young people compare themselves with their peers and neighbours. Children who see that their classmates are more successful might either feel encouraged to try harder, or feel discouraged and give up altogether. In an environment where a majority is unable to meet societal expectations, deviant subcultures might develop.
5. *Competition models* imply that peers compete for grades as well as later job opportunities, which might be more difficult to secure for poor children in affluent neighbourhoods.

The first three models can be summarised as "advantages of advantaged neighbours", while the latter two would be "disadvantages of advantaged neighbours" - as such, these models can be seen as competing mechanisms which may neutralise each other.

The authors then went on to summarise the results of the available empirical studies. Included were only quantitative studies which controlled for at least one aspect of parental SES. The upshot of the review was that, at that point in time, it was not possible to make robust generalisations from the published research[1]. The results regarding adolescents' criminal activity were inconclusive. However, some tentative conclusions regarding children's educational attainment were drawn:

- Elementary school socio-economic composition appeared to have a substantial effect on children's cognitive skills.
- Educational attainment was higher among teenagers who grew up in more affluent neighbourhoods, taking family socio-demographic characteristics into account.
- Generally, affluent neighbours appeared to be an advantage where they shaped social norms and institutions that would benefit the whole community, but were a disadvantage where there was competition over scarce resources.
- The more family background characteristics were controlled, the smaller became the neighbourhood effects.

Jencks and Mayer (1990) noted that not only were neighbourhood studies on child development scarce, but the analytic methods to study neighbourhood effects were underdeveloped as well. Identified as a major challenge was the unresolved question which

[1] Teenage sexual behaviour appeared to be influenced by neighbourhood characteristics, however these outcomes are not subject of the present review.

family characteristics should be controlled for to obtain unbiased estimates of neighbourhood effects. Most family characteristics are probably not entirely exogenous (not dependent on place of residence) but partly endogenous (influenced by where the family lives). The choice of too few or too many covariates can therefore lead to over- or underestimation of neighbourhood effects. The reviewers also highlighted the need for longitudinal data to measure changes in neighbourhood conditions as well as cumulative effects. Other research recommendations were to examine whether the effects of neighbourhood characteristics are linear, and to investigate possible interactions – whether poor families are more sensitive to living in disadvantaged neighbourhoods than affluent families are to living in poorer neighbourhoods.

Leventhal and Brooks-Gunn (2000)

Drawing on Jencks and Mayer (1990), Leventhal and Brooks-Gunn (2000) undertook what to date is still the most comprehensive systematic review on neighbourhood effects in relation to child and adolescent well-being. The review included studies that were published between 1990 and 1998. The outcomes considered were school readiness and achievement, behavioural and emotional problems, and sexuality and childbearing[1]. Only studies which attempted to adjust for family-level covariates were included. Findings were summarised by age groups and by type of neighbourhood exposure (census-derived versus measures of social organisation).

The majority of the empirical studies conducted by then had examined associations with neighbourhood characteristics derived from census data, mainly mean neighbourhood socio-economic status (SES), residential stability, and ethnic diversity. Twenty-one studies on school readiness/achievement were identified and 14 studies on behavioural/emotional problems. The studies came almost exclusively from the US, with the exception of one Scottish study on educational attainment (Garner and Raudenbush, 1991) and one British Study on youth's delinquency (Sampson and Groves, 1989). Of the 21 studies examining attainment, all but one found an association with neighbourhood SES, while of the studies on behaviour and emotional outcomes, all were in support of a relationship. However, associations varied widely and with no clear pattern by child age, gender or ethnicity. In general, neighbourhood effects were found to be small to modest, accounting for 5% to 10% of the variance in the studied outcomes after allowing for the influence of family-level

[1] Findings regarding sexuality and childbearing are not part of the present review.

covariates. Across all outcomes, neighbourhood SES was more important than ethnic composition or residential stability. Neighbourhood poverty and neighbourhood affluence appeared to have different implications: across studies, neighbourhood affluence was associated more strongly and positively with achievement, while low SES neighbours and residential instability had negative effects on behavioural and emotional outcomes.

Studies on neighbourhood social organisation attempted to shed light on the pathways through which neighbourhood characteristics such as socio-economic disadvantage might affect children and adolescents. The authors of the review noted that by 1998, most publications were theoretical in nature, aiming to develop research frameworks and conceptual models. Three main themes emerged from these papers, further developing the ideas of Jencks and Mayer (1990) while being complementary rather than mutually exclusive:

1. "Institutional resources" include the availability, accessibility and quality of services such as childcare, schools and libraries, which might influence children's learning experiences and attainment. Employment opportunities are also part of this theme, potentially affecting children via family income and via causing expectations and educational aspirations.

2. "Relationships" refers to pathways via parental mental health, parenting practices, and social support networks available to the family.

3. The concept of "norms/collective efficacy" draws on social disorganisation theory (Shaw and McKay, 1942) and is about cohesiveness and the degree to which residents monitor the behaviour of others and are willing to intervene on behalf of the common good, thus influencing perceptions of safety and also behaviours such as parenting practices.

The reviewers then presented quantitative as well as qualitative studies which addressed the above mechanisms. They concluded that overall, the evidence from empirical research was still too scarce to draw any firm conclusions. The findings relevant to the present review are summarised below.

Studies on institutional resources: Several US studies reported positive associations between local early intervention programmes such as the Head Start programme, and younger children's cognitive and socio-emotional development (Zigler, 1978; McKey et al., 1985; Lee et al., 1990; Campbell and Ramey, 1994; Reynolds, 1994; Brooks-Gunn, Klebanov and Liaw, 1995). The study by Lee et al. (1990) showed that children from poor families generally benefitted from attending Head Start or indeed any preschool programme, but also that early gains were diminished after school entry. One possible explanation offered by the authors is that the schools which these children go on to attend are likely to be disadvantaged in various ways and might fail them. However, no study could be identified which had examined whether for school-age children, neighbourhood effects were mediated via school characteristics.

Studies on relationships: Only one study tested the hypothesis that neighbourhood poverty influences maternal levels of depression, and found no association (Klebanov, Brooks-Gunn and Duncan, 1994). There was however evidence for associations between neighbourhood disadvantage and aspects of parenting. Parents who perceived their neighbourhood as more dangerous and stressful were more likely to report the use of harsh discipline and stricter supervision/monitoring (Furstenberg et al., 1993; Earls, McGuire and Shay, 1994; Simons et al., 1996; Jarrett, 1997). Another study by Klebanov et al. (1998) showed that the quality of the home learning environment mediated the association between neighbourhood SES and young children's cognitive ability. Similarly, Greenberg et al. (1999) found evidence of mediation via the home learning environment for school-age children's social competence and reading scores. Again, all of these studies were from the US. While it had been proposed that neighbourhood social disorganisation might affect child outcomes via lack of routines and structures such as regular meal-and bedtimes (Wilson, 1987), this hypothesis had by then not been empirically tested.

Studies on norms/collective efficacy: The reviewers found good evidence in support of the norms/collective efficacy model. "Collective efficacy", a combined measure of informal social control and social cohesion, was shown to be negatively associated with adolescent delinquency (Sampson, 1997). Aneshensel and Sucoff (1996) found that low neighbourhood SES was associated with adolescents' perceptions of greater ambient hazards, a measure of potential threat and danger with items such as violent crime, which was in turn associated with symptoms of depression and anxiety as well as conduct and defiant disorder. Informal social control was also negatively associated with adolescent problem behaviour in a study by Elliott et al. (1996).

The review concluded by summarising the limitations of the available studies and making research recommendations. An important point is the issue of endogeneity or selection bias – the fact that neighbourhood residence is not random. As did Jencks and Mayer

(1990), the authors stressed the importance of taking care when selecting family-level confounders. Another challenge identified is the need to move beyond census data to ensure that important context variables are not missed, and to gain a better understanding of the pathways involved in neighbourhood effects. The authors suggested making use of administrative data, such as prevalence of crime or quality of schools. Community surveys and systematic social observations designed to measure the social organisation of a neighbourhood were highlighted as promising routes for further research. Another recommendation was the use of multilevel modelling techniques, to enable the calculation of the variability in the studied outcomes between neighbourhoods. Finally, the reviewers called for the use of longitudinal data.

In summary, the review by Leventhal and Brooks-Gunn (2000) suggests small to moderate neighbourhood effects on children's cognitive and behavioural development, as well as providing a theoretical framework on the mechanisms through which these effects might operate. At the time, the empirical research on potential pathways was still scarce, especially with regards to the influence of institutional resources. What is conspicuous is the dominance of US research within the timeframe of the review, with almost all studies included being based on US data.

2.2.2 Neighbourhoods and socio-emotional development

2.2.2.1 Reviews

Sampson, Morenoff and Gannon-Rowley (2002)

Two years after Leventhal and Brooks-Gunn (2000), Sampson, Morenoff and Gannon-Rowley (2002) published a review of only those studies which had investigated the effects of neighbourhood social processes on child and adolescent problem behaviour and delinquency, as well as adult mental health. The rationale for this review was that by this time a shift had occurred in neighbourhood research, away from merely measuring concentrated poverty towards hypothesising and investigating the social processes through which neighbourhoods might affect their residents. Under that premise, Sampson et al. (2002) searched for studies which had measured at least one aspect of neighbourhood social organisation. Forty studies were identified, published between 1996 and 2001. Overall, the review by Sampson et al. (2002) found that the by then conducted research on neighbourhood social processes relied heavily on crime statistics data, with most studies having a crime-related outcome.

Only eight of the reviewed studies had investigated problem behaviour and mental health in children and adolescents. All of these studies were based on US data. Two of the studies on child and youth outcomes had also been part of the review by Leventhal and Brooks-Gunn (Aneshensel and Sucoff, 1996; Elliott et al., 1996). Concepts of collective efficacy, perceived neighbourhood disorder (such as deteriorating buildings, drinking alcohol in public and graffiti) as well as lack of safety (perceived and objective) appeared to be most consistently related to child and adolescent problem behaviour, emotional distress and delinquency (Aneshensel and Sucoff, 1996; Elliott et al., 1996; Shumow, Vandell and Posner, 1998; Stiffman et al., 1999; Gorman-Smith, Tolan and Henry, 2000; Kowaleski-Jones, 2000).

Very interesting are the results from two papers which had analysed data from the US Moving To Opportunity (MTO) programme[1], an experimental study designed to test whether offering families from high-poverty inner-city areas the opportunity to move into

[1] The study involved the random assignment into three groups. The first group (experimental group) was offered vouchers to be used only for moving into areas with poverty levels below 10%, the second group was also offered a voucher but could freely choose where to move, and the third was the control group not offered any financial assistance.

low-poverty areas would lead to improvements in a range of child and adult outcomes. Two years after enrolment into the programme, moving to more affluent areas was associated with a reduction in arrests for juvenile delinquency (Ludwig, Duncan and Hirschfield, 2001), as well as improvements in boy's problem behaviour (Katz, Kling and Liebman, 2001). However, because only 50% of the families in the experimental group took up the offer to move, selection bias was still a potential problem that needs to be considered when interpreting these results.

The neighbourhood processes which emerged from the reviewed studies as having independent validity are similar to those that had been proposed by Leventhal and Brooks-Gunn (2000). Sampson et al. (2002) identified four instead of three potential mechanisms:

1. *Social ties/interaction:* This theme is very similar to the notion of "social relationships", but explicitly mentions the concept of social capital as it relates to interactions between neighbours.
2. *Norms and collective efficacy*
3. *Institutional resources*
4. *Routine activities:* The fourth theme is concerned with patterns of land use and the built environment. This includes the mix of residential and commercial land use, e.g. the presence of stores, shopping malls, bars, industrial units, vacant lots, and the availability of public transport.

Regarding the associations between signs of social and physical disorder on the one hand and youth delinquency on the other, the reviewers expressed concern that these might be spurious, because of evidence that disorder and crime share the same predictors such as collective efficacy (Sampson and Raudenbush, 1999). Signs of disorder might be seen as a proxy for low collective efficacy, while its perception can be an important predictor of maternal and child distress.

In their summary, the reviewers pointed out that while they had been focusing on neighbourhood social processes, concentrated poverty and other measures of neighbourhood composition were still important factors for residents' well-being. Some studies showed that social processes partly mediated these relationships.

In addressing the methodological challenges encountered by neighbourhood research and possible new directions, the authors made several important points. The first is the issue of selection bias, noted also in the previous reviews and here identified as the biggest challenge facing neighbourhood research. Related is the balance between adjusting for individual-level control variables in the attempt to minimise selection bias, and the danger of "over-controlling" if factors which are considered confounders are actually mediators (or both), i.e. lie on the pathway between neighbourhood characteristics and the outcome of interest. For example, adjusting for maternal depression might "control out" a potentially important mediating factor. A further complication of neighbourhood research is that residents do not statically stay within their immediate neighbourhood, but use amenities and facilities of adjacent areas. Defining neighbourhood boundaries is another problem, given that most studies rely on census geographies. The authors suggested using definitions that take street patterns and barriers such as major roads into account. A trend that was welcomed is the measurement technique of systematic social observation, whereby interviewers provide ratings of the area based on their observations of physical and social disorder or their feelings of safety. Finally, the authors highlighted the dynamic nature of neighbourhoods and the need of longitudinal data to capture change.

Sellström and Bremberg (2006) also conducted a systematic review of studies on neighbourhood effects on children's and adolescents' health and well-being, but only five of the eligible papers had studied behavioural problems. In the interest of an inclusive overview of relevant research, these will be summarised and discussed together with the individual studies retrieved for the present review.

2.2.2.2 Overview of individual studies

The literature search retrieved 43 studies which had investigated a socio-emotional outcome. The details of these studies can be found in Table 11-1 in Appendix I.

The outcomes that have been studied were diverse, but were mostly measured via validated instruments. They can be divided into internalising and externalising problem behaviour, mental illness, delinquency and pro-social behaviour. Externalising problems included physical aggression, misconduct, antisocial behaviour and hyperactivity. Internalising problems included psychological distress, emotional problems, anxiety and depression. Of 43 individual studies, 16 had used longitudinal data, and 20 had employed multilevel analysis techniques.

Only eight studies were based on UK data. Six of the UK studies were supportive of an association between at least one neighbourhood aspect and a child emotional or behavioural outcome (Barnes and Cheng, 2006; McCulloch, 2006; Meltzer et al., 2007; Odgers et al., 2009; Flouri, Mavroveli and Tzavidis, 2012; Odgers et al., 2012), while two studies were unsupportive (Ford, Goodman and Meltzer, 2004; Flouri, Tzavidis and Kallis, 2009).

2.2.2.3 Variability in socio-emotional outcomes between neighbourhoods

While 20 of the individual studies had used multilevel modelling, only 12 of them reported the between-neighbourhood variability (Intraclass Correlation Coefficient, ICC) in the outcome of interest[1]. Unconditional ICC's (calculated before adjustment for any covariates) varied widely, ranging from 2% to 11% for problem behaviour and from 0% to 21% for pro-social behaviour.

2.2.2.4 Neighbourhood deprivation and affluence

Neighbourhood deprivation is one of the most studied exposures in neighbourhood research and is usually measured via compositional variables derived from census data, such as the percentage of poor households per area. Census data are readily available for use with administrative boundaries in most countries, making them attractive for researchers.

While in the earlier reviews associations between neighbourhood deprivation and child socio-emotional outcomes were supported by almost all studies, later results have been more varied. Still, the majority of the here reviewed research found positive independent associations with either more externalising behaviour (Kalff et al., 2001; Schneiders et al., 2003; McCulloch, 2006; Oliver et al., 2007; Kohen et al., 2008; Edwards and Bromfield, 2009; Odgers et al., 2009; Lima et al., 2010; Odgers et al., 2012), more internalising behaviour (Schneiders et al., 2003; Xue et al., 2005; Flouri et al., 2012), delinquency (Gorman-Smith et al., 2000), more peer problems (Flouri et al., 2012) or more frequent mental health service use (van der Linden et al., 2003). These findings are in contrast to the negative results of six studies which found no relationship between neighbourhood

[1] The higher the ICC, the larger are the observed differences between neighbourhoods. A detailed explanation of multilevel models and the calculation of between-neighbourhood variability can be found in chapter five (section 5.2.2).

deprivation and externalising behaviour after controlling for family-level covariates (Kowaleski-Jones, 2000; Rankin and Quane, 2002; Drukker et al., 2003; Ford et al., 2004; Simons et al., 2004; Flouri et al., 2009). One Canadian study reported a negative association between concentrated poverty and physical aggression (Romano et al., 2005). Two studies had also examined whether the positive construct of pro-social behaviour was influenced by neighbourhood disadvantage but found no association (Rankin and Quane, 2002; Romano et al., 2005).

Conceptually different from measuring disadvantage, the study of neighbourhood affluence has been proposed to improve understanding of why children in advantaged environments do better (Massey, 2001). Because using measures of deprivation and affluence in the same analysis might lead to problems with multicollinearity, Massey (2001) developed the "Index of Concentration at the Extremes" or ICE. The ICE measures the proportions of disadvantage and affluence in a neighbourhood along a continuum, where the neutral point would be a balance between the two. It was used in the study by Carpiano, Lloyd and Hertzman (2009), who found that neighbourhood affluence predicted fewer behaviour problems in 5 year old children, but that the shape of the association was curvilinear: better outcomes were found in more heterogeneous neighbourhoods, where proportions of disadvantage and affluence were relatively equal. The Australian SEIFA[1] however, a similar continuous measure of advantage to disadvantage, showed only a weak association with children's socio-emotional adjustment in a recent longitudinal study among 4-9 year olds, although this study did not examine linearity (Sanson, Smart and Misson, 2011). Three studies had measured neighbourhood affluence via median household income and also reported relationships with less problem behaviour (Kohen et al., 2002; López Turley, 2003) and fewer emotional problems (Shumow et al., 1998).

Analyses of neighbourhood effects are complicated by the fact that neighbourhoods themselves are dynamic and changing over time. Such changes and their effects have rarely been measured. It would strengthen the theory behind neighbourhood research if it could be shown that positive changes such as decreasing poverty levels led to improved outcomes for (stable) residents. However, as highlighted by a recent study, these relationships are not clear-cut (Leventhal and Brooks-Gunn, 2011). The study looked at the effects of changes in neighbourhood poverty rates on child behavioural outcomes over a ten-year period and found variations by initial neighbourhood poverty status as well as by

[1] Socio-Economic Indexes for Areas

gender: in neighbourhoods with high initial poverty, decreasing poverty was associated with *more* problem behaviour compared to stable high poverty neighbourhoods, a relationship that was much stronger for boys than for girls. An explanation offered by the authors is that gentrification and the influx of new, affluent residents might initially trigger resentment among youths who do not benefit from the changing profile of their neighbourhood. For moderate and low poverty neighbourhoods, associations were in the expected direction but also less pronounced or not at all present for girls. The role of gender in these relationships is discussed in more detail below (section 2.2.2.9).

2.2.2.5 Neighbourhood social processes

Most of the reviewed studies included measures of social processes or social organisation at the neighbourhood level, using a diversity of constructs such as collective efficacy, neighbourhood problems, social disorder, social capital, cohesion, social climate, sense of belonging or feelings of safety. Often, several different measures were combined to form an overall index or were analysed simultaneously in the same model, making it difficult to review their effects separately.

Studies also differed by the source of information on neighbourhood processes. Ideally, this information would be independent of the person reporting on the child outcomes. Having the same informant reporting on the exposure as well as the outcome might have led to some degree of same-source bias, especially if the study design was cross-sectional. The issue of same-source bias can be addressed by using interviewer assessments or community surveys (independent samples from the same neighbourhoods the study participants live in), or by aggregating individual responses. Other independent sources of information are crime statistics. Thirteen studies had measured neighbourhood social processes via self-reported parental or child perceptions. Six studies had used interviewer observations, community surveys, aggregated responses or crime statistics to measure the neighbourhood exposure, while another six studies had information from both self-reports and independent informants.

An independent relationship between at least one perceived aspect of neighbourhood social organisation and a child emotional or behavioural outcome was supported by 12 cross-sectional studies (Shumow et al., 1998; Stiffman et al., 1999; Kohen et al., 2002; Caughy, O'Campo and Muntaner, 2003; Curtis, Dooley and Phipps, 2004; Romano et al., 2005; Barnes and Cheng, 2006; Meltzer et al., 2007; Edwards and Bromfield, 2009; Lima et al., 2010; Eriksson et al., 2012; Singh and Ghandour, 2012) and three longitudinal studies (Gorman-Smith et al., 2000; Guerra, Rowell Huesmann and Spindler, 2003; Sanson et al., 2011). Three studies with a self-reported exposure were unsupportive of an association (Kowaleski-Jones, 2000; Rankin and Quane, 2002; Renzaho and Karantzas, 2010).

Among the 12 studies which made use of an unbiased source of information or aggregated measure, seven found significant associations with a child outcome (Drukker et al., 2003; van der Linden et al., 2003; Curtis et al., 2004; Simons et al., 2004; Xue et al., 2005; Kohen et al., 2008; Odgers et al., 2009), while three did not (Stiffman et al., 1999; Kohen et al., 2002; Edwards and Bromfield, 2009). Two studies had used a composite measure of neighbourhood risk which included both respondent's perceptions and interviewer observations / crime statistics, and both were supportive of a positive association between the risk measure and externalising behaviour (Shumow et al., 1998; Greenberg et al., 1999). It appears that the proportion of unsupportive results was larger among the studies which had used independent sources of information on the neighbourhood exposure.

Social processes as mediators

Three studies reported evidence for social processes mediating the relationship between neighbourhood socio-economic status and child problem behaviour. Neighbourhood collective efficacy measured via a community survey mediated the association between concentrated disadvantage and child mental health (Xue et al., 2005). The path analysis by Kohen et al. (2008) found no direct relationship between neighbourhood income and problem behaviour, but did find an indirect pathway via neighbourhood cohesion measured via aggregated parent reports. In the study by Edwards and Bromfield (2009), the link between neighbourhood disadvantage and child conduct problems was partially mediated by parental perceptions of safety and belonging.

2.2.2.6 Institutional resources

Institutional resources were investigated by only two studies. Kowaleski-Jones (2000) had measured maternal perceptions of school quality among a sample of adolescents, and found that higher perceived quality was associated with less aggressive behaviour. In the study by Renzaho and Karantzas (2010), parents were asked about their perceptions of neighbourhood infrastructure and accessibility as well as neighbourhood services. Perceived lack of infrastructure, which included access to parks and play spaces, was related to more behavioural difficulties, while no association was found with a lack of basic services such as shopping facilities and medical clinics.

2.2.2.7 Experimental/quasi-experimental designs

As described in the review by Sampson et al. (2002), the initial findings of the US Moving To Opportunity (MTO) programme[1] on adolescents' mental health and delinquency had been encouraging (Katz et al., 2001; Ludwig et al., 2001). However, later evaluations produced very mixed results. Four to seven years after randomisation there were no differences in parent-reported behaviour for children[2] in the experimental groups compared to the control group (Sanbonmatsu et al., 2006). In adolescents, moving had positive effects for girls but not for boys. Adolescent girls who had moved into low-poverty areas had large benefits in mental health outcomes, while for male youth moving into more affluent neighbourhoods was associated with adverse effects regarding injuries and substance abuse, and no differences regarding their mental health (Kling, Liebman and Katz, 2007). Further, reduced delinquency was observed in female youth from the experimental groups, but for male youth a reduction in arrests for violent crime was accompanied by an increase in property crime and problem behaviour (Kling, Ludwig and Katz, 2005).

Similarly negative were the results of a follow-up study on the Yonkers Family and Community Project (Fauth, Leventhal and Brooks-Gunn, 2007). The Yonkers project was a residential mobility programme aimed at low-income, minority families living in impoverished, segregated neighbourhoods. As with MTO, families were selected via lottery, and winners were relocated to newly built townhouses in middle-class, White areas. Seven years after relocation, 128 "mover" and 93 "stayer" families were re-interviewed. Results showed marginally significant *negative* effects for children of movers, who were slightly more likely to exhibit anxious/depressed problems and also slightly more likely to have used alcohol or drugs in the past year, the latter association being only true for older children. A significant interaction effect by age was found also for hyperactivity, with movers reporting more problems than stayers only among older children.

[1] The MTO programme involved the random assignment into three groups. The first group (experimental group) was offered vouchers to be used only for moving into areas with poverty levels below 10%, the second group was also offered a voucher but could freely choose where to move, and the third was the control group not offered any financial assistance.

[2] At baseline, children were 6-14 years old.

One possible explanation for these findings is that the disruption associated with moving itself had negative effects which offset potential benefits. A recent review found associations between the number of residential moves and increased behavioural problems during childhood and adolescence (Jelleyman and Spencer, 2008). Also, according to Sanbonmatsu et al. (2006), about 80% of families in the MTO experimental group moved again at least once after the random assignment, and subsequent moves tended to be again to more disadvantaged areas, thus diluting the treatment effect (this fact can also be read as an argument against the premise of such relocation programmes - that it might be enough to move poor families elsewhere without changing anything about their individual circumstances).

2.2.2.8 Evidence of mediation via maternal mental health and parenting

One of the proposed mechanisms through which neighbourhoods might influence children's emotional health and behaviour is via family processes (Leventhal and Brooks-Gunn, 2000).

A mediating relationship via maternal mental health was tested by six studies, four of which were supportive (Greenberg et al., 1999; Kohen et al., 2008; Sanson et al., 2011; Flouri et al., 2012). Two studies did not find evidence of mediation (Barnes and Cheng, 2006; McCulloch, 2006). Kohen et al. (2008), using structural equation models, showed that the relationship between an aggregated measure of neighbourhood cohesion and behaviour problems amongst 4-5 year olds was mediated via maternal depression, which in turn was associated with punitive parenting. The study by Flouri et al. (2012) had used MCS data and found that the link between neighbourhood deprivation and three-year-old children's internalising behaviour was mediated by maternal psychological distress. The neighbourhood exposures in the other two studies that were supportive of mediation were mother-reported subjective measures such as belonging and perceived safety. It is therefore possible that the mediating association was confounded by same-source bias. Mothers who are more distressed might have bleaker perceptions of their surroundings as well as reporting more negatively on their child's behaviour, possibly leading to spurious associations.

Three studies found evidence for mediation via parenting practices (Kohen et al., 2008; Sanson et al., 2011; Odgers et al., 2012), while the results obtained by McCulloch (2006) regarding a mediating association between neighbourhood type and externalising behaviour via the home learning environment were inconclusive.

2.2.2.9 Variations by child and family characteristics

Several studies found evidence of cross-level interaction effects, where the relationship between a neighbourhood level exposure and an outcome of interest varies across categories of an individual-level characteristic. Cross-level interactions were reported for child gender, child age and family-level disadvantage.

Gender

It has been theorised that neighbourhood factors might affect girls and boys differently, because of known gender differences in the development of externalising and delinquent behaviour and because of evidence that girls are more closely supervised by parents (Kroneman, Loeber and Hipwell, 2004).

It is difficult to find a clear pattern regarding the role of gender from the here reviewed research. Only eight studies tested whether neighbourhood effects varied by child gender, six of which reported significant interactions (Greenberg et al., 1999; Katz et al., 2001; Kling et al., 2005; Kling et al., 2007; Leventhal and Brooks-Gunn, 2011; Odgers et al., 2012).

Both Greenberg et al. (1999) and Leventhal and Brooks-Gunn (2011) reported that the associations with the neighbourhood exposure ("neighbourhood risk" and change in neighbourhood poverty levels, respectively) were stronger for boys than for girls. Odgers et al. (2012) found that boys in deprived neighbourhoods did not experience expected improvements in antisocial behaviour over time. Further, moving to a better neighbourhood had led to improvements in the behaviour of boys but not girls in the early MTO study (Katz et al., 2001). From these four studies, it would appear that boys are more susceptible to processes at the neighbourhood level. But, the later MTO studies showed that it was teenage girls who had gained large benefits from moving to more advantaged neighbourhoods especially regarding their mental health, while for teenage boys there were neutral or even adverse effects. One potential explanation for the latter findings according to Kling et al. (2007) is that male youth might have found it more difficult than females to adapt to their new neighbourhoods in the sense of "fitting in". For girls, it was further speculated that moving to lower poverty neighbourhoods reduced exposure to abuse and sexual harassment, factors which might have been less relevant for boys.

Child age

Although earlier research had focused more on adolescent outcomes, especially on adolescent delinquency, associations between neighbourhood characteristics and socio-emotional development were generally demonstrated for children at all ages. Interactions by child age had been tested by two studies. López Turley (2003) had analysed data from 3-12 year olds and found associations between neighbourhood median income and behaviour only in children older than eight. In the evaluation study of the Yonkers project, the effect of moving on hyperactivity depended on child age at programme entry. Among 8-11 year olds, movers had slightly fewer hyperactivity problems, while among children who were older than 12 years at programme entry, movers had markedly more problems, and these differences were larger the older the children were (Fauth et al., 2007). These results suggest that the neighbourhood environment becomes more influential as children get older. It is likely that the importance of peer groups increases with age, so that loosing friends due to a residential move is more relevant for older children. In addition, older children and teenagers might spend more time outside unsupervised.

Family socio-economic background

There is some evidence suggesting that relationships with neighbourhood disadvantage are dependent on the socio-demographic background of the family. One Canadian study with a large sample of 4-11 year olds found fewer behavioural problems in children from well-off families living in disadvantaged neighbourhoods, and more problems in children from poor families living in advantaged neighbourhoods when compared to their neighbours (Boyle and Lipman, 2002).

2.2.3 Neighbourhoods and cognitive development

The literature search retrieved 27 individual studies published since 1998, but no reviews. Study details are presented in Table 11-2 in Appendix I. Seventeen studies had used longitudinal data. Again, the majority of studies were from the US, with only four studies stemming from the UK. The cognitive outcomes examined by the reviewed studies were either measures of educational attainment such as school-administered test scores and teacher ratings, or measured via a range of different validated instruments which were administered during the study interview.

Of the UK studies, three were supportive of an independent relationship between a neighbourhood characteristic and a cognitive outcome (McCulloch and Joshi, 2001; McCulloch, 2006; Rasbash et al., 2010). One study had measured the variability between neighbourhoods and schools before adjustments and found significant variation (Leckie, 2009).

2.2.3.1 Variability in cognitive outcomes between neighbourhoods

As was the case for the socio-emotional child outcomes, the reported between-neighbourhood variability (Intraclass Correlation) in children's cognitive skills was very variable, even though it was reported by only five studies. Unadjusted ICC's ranged from 4% for English GCSE results between small areas in the UK (Leckie, 2009) to 34% for early vocabulary scores between US census tracts (Vaden-Kiernan et al., 2010). These estimates are however not comparable, because the study by Leckie (2009) simultaneously took the variability between schools into account as discussed in more detail below (section 2.2.3.4).

2.2.3.2 Neighbourhood deprivation and affluence

Ten studies reported a statistically significant negative relationship between neighbourhood socio-economic disadvantage and children's cognitive test scores, net of family-level confounding factors (McCulloch and Joshi, 2001; Rauh et al., 2003; Caughy and O'Campo, 2006; McCulloch, 2006; Kohen et al., 2008; Sampson, Sharkey and Raudenbush, 2008; Lloyd, Li and Hertzman, 2010; Rasbash et al., 2010; Greenman, Bodovski and Reed, 2011; Sharkey and Elwert, 2011). Two studies were unsupportive of an association. These were a US study by Ainsworth (2002), who found that in a large sample of over 10,000 residentially stable 10th graders only the proportion of high status residents was associated with educational achievement after adjusting for family socio-economic position. The other was a small US study of elementary school children which had looked at both neighbourhood and school characteristics in an attempt to explain the Black-White achievement gap (Burchinal et al., 2011). The quality of the school environment in this study was measured in detail via direct classroom observations and was found to be an important predictor of the gap, whereas in the fully adjusted model neighbourhood disadvantage was associated with *better* math achievement.

Neighbourhood affluence was the exposure variable used by ten studies, all of which supported a positive relationship with children's cognitive outcomes. Two Canadian studies had used the Index of Concentration at the Extremes in large samples and found associations with cognitive test scores among 5-year-olds (Carpiano et al., 2009), and educational achievement in grade 4 among urban but not rural neighbourhoods (Lloyd and Hertzman, 2010). A similar measure (SEIFA) was used by a longitudinal Australian study, which showed that neighbourhood advantage at ages 4-5 was associated with better learning competencies at ages 8-9 (Sanson et al., 2011). Vaden-Kiernan (2010) from the US derived "High SES" and "Low SES" neighbourhood factors from 40 census measures via factor analysis and reported links between High SES and better letter identification scores as well as between Low SES and lower vocabulary and maths scores among a large sample of 3-4 year olds.

Other studies had measured affluence via neighbourhood median income, all concluding that a statistically significant relationship exists between neighbourhood affluence and children's cognitive skills (Klebanov et al., 1998; Kohen et al., 2002; López Turley, 2003; Oliver et al., 2007; Dupere et al., 2010; Sastry and Pebley, 2011). The shape of the relationship was investigated by three studies. López Turley (2003), using a large sample of 3-12 year olds, tested a quadratic term in a multiple regression model, finding no evidence of nonlinearity. Carpiano et al. (2009) arrived at the same result also by including a quadratic term in a multilevel regression model in the analysis of a large sample of 5 year olds. However, results of a recent study by Dupere (2010) which used hierarchical linear growth curve models suggested that the association between their measure of neighbourhood advantage (constructed from median income and the proportion of highly educated people in the neighbourhood) and reading/vocabulary test scores was curvilinear, levelling off at moderate levels of advantage.

2.2.3.3 Neighbourhood social processes

Measures of neighbourhood social organisation did not feature prominently in the studies on cognitive outcomes, and among the five studies which had tested possible associations the findings were mixed.

Three studies were supportive of an independent relationship. Parent-reported low neighbourhood cohesion as well as interviewer-reported social disorder were negatively associated with 4-5 year old children's verbal ability in a large Canadian study (Kohen, 2002). This finding was confirmed in a later analysis of the same data which used Structural Equation Models and an aggregated measure of parent-reported neighbourhood cohesion (Kohen et al., 2008). In the path model, sense of cohesion was on the pathway between neighbourhood disadvantage and verbal ability. The third supportive study came from the US and reported a positive relationship between parent-reported neighbourhood social capital and children's cognitive competence among a sample of 200 African-American children aged 3-4 years, however social capital did not mediate the association between neighbourhood poverty and the outcome (Caughy and O'Campo, 2006).

Greenberg et al. (1999) on the other hand found their measure of neighbourhood risk (perceptions of safety assessed by parents as well as interviewers) to be unrelated to children's cognitive test scores after adjustment for family level confounders. Sanson et al. (2011) tested the association between parents' sense of neighbourhood belonging and 8-9 year olds learning competencies, finding no independent relationship.

2.2.3.4 Institutional resources – the role of schools

Six studies had considered schools as a potentially contributing factor to the "neighbourhood effect". Other types of institutions had not been examined by the reviewed research.

All six studies found that schools played a significant role. Ainsworth (2002) reported that higher teacher quality and a better school atmosphere (with items such as emphasis on achievement, high teacher and student morale) were associated with higher educational achievement among 10th graders. The study by Burchinal et al. (2011) has already been mentioned above. It showed that the Black-White achievement gap among a sample of US elementary school children was due mainly to family and school factors, with schools accounting for about one third of the gap. School characteristics that were associated with reading and maths were school intake, the child-teacher ratio and the quality of teaching. Dupere (2010) found that the association between neighbourhood disadvantage and reading scores was mediated mainly by school advantage, measured via the proportion of children not eligible for free school meals.

Two studies used data from the English National Pupil Database to partition the variability in GCSE scores between neighbourhoods and schools using cross-classified multilevel models. Leckie (2009) estimated that before any adjustments for family level confounders, about 4% of the overall variance in GCSE scores was attributable to differences between neighbourhoods, 23% to differences between secondary schools and 3% to differences between the primary schools pupils had been attending. In a later study the National Pupil Database was used again to include Local Education Authority (LEA) and family contexts in the model. The presented estimates were adjusted for child age, gender, ethnicity, eligibility for free school meals and statement of special educational needs, and at the neighbourhood level for the Income Deprivation Affecting Children Index (IDACI). In this analysis, 37.8% of the overall variance in GCSE scores was attributed to pupils, 40.4% to families, 10.3% to secondary schools, 8.5% to primary schools, 1.8% to neighbourhoods (Lower Layer Super Output Areas) and 1.3% to LEAs (Rasbash et al., 2010). These analyses, which had used very large samples, suggest that there is more variation between schools than between neighbourhoods, and underline the importance of taking schools into account when estimating neighbourhood effects on children's cognition.

The most salient example for the relevance of schools is probably the analysis of a US social experiment by Dobbie and Fryer (2011), which is described in detail under the next subheading.

2.2.3.5 Experimental/quasi-experimental designs

The aforementioned Moving To Opportunity programme was also evaluated with respect to children's and youths' cognitive test scores (Sanbonmatsu et al., 2006). The disappointing finding was that 4-7 years after enrolment into the programme there was no positive treatment effect for any age group. Similarly, the study by Fauth et al. (2007) which had followed up participants in the Yonkers project described earlier, found no significant differences between "movers" to middle-class areas and "stayers" in the old public housing units regarding children's cognitive test performance. Tests whether associations between mover status and cognitive outcomes differed by the age of the children were also negative.

One possible explanation for these findings is that compared to the control group, the move to low-poverty neighbourhoods did not lead children to attend substantially better performing schools in either programme. While “movers” did move to areas that were considerably less poor than their original neighbourhoods, the placement neighbourhoods were not truly affluent. Further, as mentioned earlier (section 2.2.2.7), subsequent moves of experimental group families tended to be again to poorer areas (Sanbonmatsu et al., 2006).

Contrasting the results of the above residential mobility projects, another US social experiment which combined community programmes with the provision of high-quality charter schools appeared to be much more successful (Dobbie and Fryer, 2011). The “Harlem Children’s Zone” (HCZ) was developed in 1997 in Harlem, New York, to counter the Black-White achievement gap which emerges among US children at kindergarten age and widens as children grow older. The HCZ project included over 20 community programmes (including early childhood programmes, after school activities and family health programmes) and the opening of two Promise Academy charter schools. These schools had extended school hours, emphasised the recruitment of high-quality teachers and also offered additional tutoring, free medical services, free healthy meals and extra support for parents. Because of oversubscription, places were allocated via a lottery, a fact which was exploited in the study by economists Dobbie and Fryer (2011). The researchers used instrumental variable analysis to compare academic achievement between lottery winners (treatment) and lottery losers (control) and found remarkable treatment effects: compared to lottery losers, middle school children who won the lottery had strong gains per year in state test scores in math and small gains in English Language Arts (ELA), while elementary school lottery winners had strong gains in both math and ELA. The size of the effects was estimated to be large enough to close the Black-White achievement gap for children attending elementary school from kindergarten through to 5^{th} grade. Further analyses showed that these gains were almost entirely due to the school, with little contribution from the community programmes. Firstly, there were no differences in gains between lottery winners who lived inside the zone versus outside the zone, and secondly, siblings of winners from inside the HCZ who were themselves not eligible for the school showed little to no effect on their achievement scores. The observed effects did not vary by gender or free lunch status.

2.2.3.6 Variations by child age

Assuming that neighbourhood effects on cognitive development operate partly through schools and peer influences, and that younger children are more supervised and less exposed to the neighbourhood environment, such effects would be expected to be stronger for older children. Findings regarding potential interactions by child age have however been mixed. McCulloch and Joshi (2001) analysed data from 4-18 year olds and found small significant associations between neighbourhood deprivation and cognitive test scores only for children aged four and five, the age of transition to school. Sastry and Pebley (2010) on the other hand, using American data from children aged 3-17, reported positive associations between median neighbourhood income and cognitive skills for all ages, but the association was even stronger for children older than eight. The evidence for time lags which is discussed in detail below also suggests that neighbourhood effects might emerge at older ages (Lloyd and Hertzman, 2010; Lloyd et al., 2010).

Interactions with other child and family variables such as child gender or family socio-economic status were not reported by any of the reviewed studies.

2.2.3.7 Time lags / length of residence

It seems reasonable to assume that the length and possibly the timing of exposure to certain neighbourhood characteristics influence the emergence of potential effects.

López Turley (2003) reported that the association between median neighbourhood income and cognitive test scores was statistically significant only for children who had lived in their neighbourhood for at least three years. The study by Sampson et al. (2008) found evidence for time lags: in causal effects models, concentrated disadvantage experienced 2-3 years earlier was associated with markedly reduced verbal ability in 6-12 year old African American children, while concurrent neighbourhood disadvantage had no significant effect. Similarly, the analysis of Canadian data on children followed from kindergarten (age 4-5) through to grade 7 (age 12-13) showed no cross-sectional relationship between median neighbourhood income and cognitive outcomes at kindergarten age, but an association between neighbourhood advantage/disadvantage measured at kindergarten age and educational achievement both at grade 4 and grade 7 assessments (Lloyd and Hertzman, 2010; Lloyd et al., 2010). A link between neighbourhood advantage at ages 4-5 and higher learning competencies at ages 8-9 was also found among Australian children (Sanson et al., 2011).

Leckie (2009) used sophisticated statistical methods to simultaneously model complex mobility of pupils between neighbourhoods and schools. He argued that potential neighbourhood effects on cognitive test scores would be smaller the shorter the amount of time spent in a given neighbourhood, and that models which allow for movements between neighbourhoods need to accommodate this or otherwise risk downward biases in estimates of between-neighbourhood variance. Using cross-classified multiple membership models, he applied weights to each neighbourhood according to the length of time a pupil had lived there. Incorporating the multiple membership element into the models improved model fit and increased the estimated between-neighbourhood variability.

Looking at the factor time in a wider sense, Sharkey and Elwert (2011) were able to demonstrate multigenerational neighbourhood effects. Their recent research on US parents and children revealed strong negative effects on children's cognitive skills if a family had lived in high poverty neighbourhoods over two consecutive generations.

2.2.3.8 Evidence of mediation via maternal mental health and parenting practices

Several studies had tested whether the association between neighbourhood socio-economic status and children's cognitive outcomes was mediated via maternal mental health or parenting practices, with mixed results.

A mediating role for parenting practices and the home environment was supported for children of different age groups by four studies (Klebanov et al., 1998; Kohen et al., 2008; Dupere et al., 2010; Burchinal et al., 2011), while five studies did not find evidence for mediation (McCulloch and Joshi, 2001; Caughy and O'Campo, 2006; McCulloch, 2006; Greenman et al., 2011; Sanson et al., 2011).

For maternal mental health, mediation was not supported by any of the here reviewed research, having been tested and rejected by four studies (Dupere et al., 2010; Vaden-Kiernan et al., 2010; Burchinal et al., 2011; Sanson et al., 2011).

2.2.4 Neighbourhood effects on maternal mental health and parenting

One of the central hypotheses of this study is that maternal mental health and parenting practices are on the pathway between neighbourhood characteristics and children's socio-emotional and cognitive outcomes. A role for neighbourhood characteristics in the development of adult depressive symptoms was generally supported by a recent review (Mair, Diez-Roux and Galea, 2008). Reviewed here is a small body of literature which explicitly examined whether neighbourhood characteristics affect the psychological well-being of mothers, their ability to provide a nurturing home environment and other parenting strategies such as the monitoring of children's activities. The literature search identified 13 studies: four studies on aspects of maternal mental health, six studies on parenting behaviour and three studies which included both outcomes.

2.2.4.1 Neighbourhood effects on maternal mental health

A possible link between maternal mental health and neighbourhood deprivation had been examined by four studies, two of which reported a statistically significant association over and above individual-level factors (Mulvaney and Kendrick, 2005; Barnes et al., 2010), while two found no independent relationship (Klebanov et al., 1994; Cutrona et al., 2000).

Mother's perceptions of neighbourhood physical and social disorder and lack of safety were however consistently related to symptoms of depression (Hill and Herman-Stahl, 2002; Christie-Mizell, Steelman and Stewart, 2003; Kotchick, Dorsey and Heller, 2005; Barnes et al., 2010). Mulvaney and Kendrick (2005) showed that living in an area of low social capital increased the risk of depressive symptoms, and that the association was either mediated or confounded by self-reported stress. While same-source bias might be a concern with regard to these findings, results were similar if the exposure was measured via aggregated responses or interviewer ratings (Cutrona et al., 2000; Hill and Herman-Stahl, 2002; Barnes et al., 2010).

2.2.4.2 Neighbourhood effects on parenting and the home environment

The parenting outcomes that have been studied in relation to neighbourhood factors can be grouped into two categories: first, measures of the mother-child relationship such as maternal warmth, the use of harsh parenting practices and strict monitoring; and second, measures of the home learning environment and the provision of educational activities.

Mother-child relationship

Neighbourhood poverty was associated with less maternal warmth in two smaller US studies (Klebanov et al., 1994; Pinderhughes et al., 2001), but not with parenting stress after adjusting for child and family characteristics in a recent large study from the Netherlands (Spijkers, Jansen and Reijneveld, 2012).

Earlier research suggested that parents living in “high-risk” neighbourhoods employ coping strategies such as high levels of monitoring and harsher discipline in an effort to protect their children (Leventhal and Brooks-Gunn, 2000). Among the studies reviewed here, perceived danger was found to be associated with higher levels of parental monitoring (Jones et al., 2005), less consistent discipline (Pinderhughes et al., 2001; Hill and Herman-Stahl, 2002) and less maternal warmth (Pinderhughes et al., 2001), but not with harsher or more punitive parenting (Pinderhughes et al., 2001; Ceballo and McLoyd, 2002). Two studies showed that the associations between perceived neighbourhood stress and lack of safety on the one hand and poorer mother-child relationships on the other were mediated via maternal psychological distress (Hill and Herman-Stahl, 2002; Kotchick et al., 2005).

Activities and home learning environment

Frech and Kimbro (2011) reported a link between neighbourhood collective efficacy and more time investment in mother-child activities such as outings and reading, while neighbourhood socio-economic disadvantage was unrelated to parenting activities. Neighbourhood disadvantage was however associated with educational parenting practices in the study by Greenman, Bodovski and Reed (2011), and with a more negative physical home environment in the study by Klebanov et al. (1994). None of these studies found evidence for mediation via maternal depression.

Taken together with the findings on mediation via maternal mental health and parenting in the studies on child socio-emotional and cognitive outcomes, the picture is mixed. It appears that perceptions of neighbourhood social processes were more consistently related to maternal mental health than measures of structural disadvantage. However it is not clear whether neighbourhood effects on mothers’ psychological well-being translate into less favourable parenting practices.

2.2.5 Main findings and limitations of past research

The literature that was published on neighbourhoods and children's socio-emotional and cognitive development since 1998 is still dominated by American research. Only few studies came from the UK, making generalisations for the UK context difficult.

Neighbourhood deprivation and affluence

Regarding the link between neighbourhood deprivation and socio-emotional development, only 15 out of the 24 here reviewed studies which had tested the association found evidence of independent relationships, which is in contrast to the overwhelmingly supportive results reported in earlier reviews. Neighbourhood affluence on the other hand was consistently related to better behavioural and emotional outcomes over and above family level factors. For cognitive outcomes, findings were more homogeneous, with most of the studies on neighbourhood deprivation and all studies on neighbourhood affluence being supportive of independent relationships. Researchers do however not contend that it is neighbourhood deprivation or affluence per se that is important, rather these are likely to be a proxy for something else which could not be measured directly and which is yet to be determined (Diez-Roux, 2004). As has been argued in a recent article, to take neighbourhood research forward it is important to uncover what this "black box" of neighbourhood effects contains, by spelling out and testing specific causal mechanisms (van Ham and Manley, 2012).

Neighbourhood social processes

Neighbourhood social processes were mainly studied in relation to socio-emotional outcomes, and significant associations were found by the majority of studies. However, studies which had used independent sources of information on the neighbourhood exposure as opposed to maternal perceptions appeared to be somewhat more likely to yield negative results. There was also some evidence for social processes mediating the relationship between deprivation and children's socio-emotional development. Studies on associations between neighbourhood social processes and cognitive outcomes produced mixed findings and were too few to draw any conclusions.

Institutional resources

Institutional resources are generally understudied. Few studies on cognitive outcomes have simultaneously examined neighbourhoods and schools, and those that did agreed on a potentially important role for the school environment. Among the studies on socio-emotional outcomes, the school context was almost completely absent.

Findings from experimental designs

The findings from two experimental residential mobility programmes from the US, the Moving To Opportunity and Yonkers projects, were on the whole rather disappointing. For the MTO, benefits were reported for adolescent girls regarding their mental health, but these were offset by detrimental effects on adolescent boys' problem behaviour. Similarly, the children whose families moved to better neighbourhoods within the Yonkers project experienced on average more emotional and behaviour problems than those whose families did not win the opportunity to move. Neither programme had any effects on children and youth educational outcomes. However, interesting and encouraging results were reported for an ambitious school project in Harlem, New York.

The role of maternal mental health and parenting

The evidence regarding mediation of neighbourhood effects via maternal health and parenting is very mixed. On the one hand, there are studies showing that maternal neighbourhood perceptions contribute to mothers' psychological distress, on the other are several papers which had to reject the hypothesis of maternal mental health being on the pathway between neighbourhood factors and child outcomes. All studies that were supportive of mediation pertained to socio-emotional outcomes, however for some of these studies same-source bias might have been a potential problem.

There is also no consensus among studies regarding the role of parenting practices, with almost equal proportions of supportive and unsupportive results. There is some evidence for maternal neighbourhood perceptions leading to poorer mother-child relationships via maternal depression and subsequently to poorer behavioural outcomes (Kohen et al., 2008), but too few studies had examined this entire pathway. Maternal depressive symptoms were not found to mediate associations between neighbourhood factors and the home learning environment, but again the number of studies which tested these associations was too small to draw definite conclusions.

Variations in neighbourhood effects by gender

Several studies showed that associations with socio-emotional outcomes varied by child gender, however a clear pattern did not emerge. Boys are perhaps more susceptible to neighbourhood factors in relation to externalising behaviour. No gender differences were reported for cognitive outcomes.

The factor time

Time lags in the emergence of neighbourhood effects were reported by some studies, pointing to the relevance of either length of exposure to neighbourhood characteristics or the existence of sensitive periods when neighbourhood factors are important, with consequences becoming manifest several years later.

2.3 Methodological challenges in neighbourhood research

The most important methodological challenges facing neighbourhood research have already been alluded to more than ten years ago in the systematic reviews by Jencks and Mayer (1990), Leventhal and Brooks-Gunn (2000) and Sampson et al. (2002). They have certainly not yet been overcome.

2.3.1.1 The context/composition debate

Selection bias or endogeneity is the most fundamental problem in neighbourhood research and is as such acknowledged by most of the here reviewed studies. As noted already by Jencks and Mayer (1990), neighbourhoods are not allocated at random. An important limitation of observational studies is therefore the possibility of selection bias, if unknown individual-level factors that affect both the outcomes as well as the choice of neighbourhood are omitted from the analyses. The potential for selection bias in observational studies leads to the context versus composition argument. Compositional effects are due to the aggregated characteristics of individuals living in an area, while contextual effects are those that originate in the area itself, such as its infrastructure (Joshi et al., 2000). This distinction has however been criticised because the characteristics of individuals and places are interrelated (Cummins et al., 2007). If individual markers are on the pathway between neighbourhood characteristics and the outcome of interest, over-adjustment for individual attributes might lead to an underestimation of contextual influences (Macintyre and Ellaway, 2003; Diez-Roux, 2004; Cummins et al., 2007).

Most studies have tried to address the issue of selection bias by controlling for a wide range of covariates. However, some might have over-controlled for individual level characteristics and thus failed to distinguish mediators from confounders. For example, one study adjusted for maternal depression without testing mediation (Ford et al., 2004), and one study adjusted for maternal depression and parenting practices (Romano et al., 2005). The study by Ford et al (2004) found no neighbourhood effect, while Romano et al (2005) reported lower levels of aggression in areas with higher levels of poverty.

Another potential limitation is the use of postcode-derived proxy data for family socio-economic position in three Canadian studies (Carpiano et al., 2009; Lloyd and Hertzman, 2010; Lloyd et al., 2010). Actual family level data were not available to the researchers, making it difficult to determine the generalisability of their results.

Three studies adopted sophisticated analysis techniques to minimise selection bias, including instrumental variable analysis, propensity scoring methods and marginal structural models (Sampson et al., 2008; Dobbie and Fryer, 2011; Sharkey and Elwert, 2011). All of these studies found evidence for neighbourhood or school effects on child cognitive development.

2.3.1.2 Definition of neighbourhood boundaries

Another major challenge in neighbourhood research is the definition of meaningful neighbourhood boundaries. “Neighbourhood” is a vague notion, which can have different meanings in different contexts and even to different people living in the same street. Further, it is thought that different aspects of neighbourhood operate at different spatial scales: institutional resources such as healthcare facilities might operate at larger scales than social processes such as trust between neighbours (Lupton, 2001; Oliver et al., 2007).

Census data were most commonly used to measure neighbourhood structural factors. These are aggregate measures, i.e. individual responses pooled to the neighbourhood or area level and treated as a community characteristic, and available only within certain administrative boundaries. Their use is often driven more by their availability and less by theoretical concepts (Rajaratnam, Burke and O'Campo, 2006). A potential problem when using Census data is that administrative boundaries such as electoral wards are somewhat arbitrary and often relatively large, and might not reflect what participants think of as their "neighbourhood" (Lupton, 2001; Diez-Roux, 2007). Also, depending on the choice of area unit the obtained statistics will be different, a phenomenon known as The Modifiable Area Unit Problem (Flowerdew, 2011).

Most of the reviewed research had used boundaries that can reasonably be assumed to correspond with natural neighbourhoods. US Census tracts, the most widely used measure across US studies, have a population of about 4,000 residents. One study had used US zip codes, which can be any population size up to tens of thousands and are therefore unlikely to be good approximations of "neighbourhood" (Kowaleski-Jones, 2000). Australian postcode areas are also large with 12,000 to 15,000 residents. In contrast, the Canadian studies that used data from British Columbia had made an effort to define neighbourhoods in consultation with local representatives (Carpiano et al., 2009; Lloyd and Hertzman, 2010; Lloyd et al., 2010).

2.3.1.3 Objective versus subjective measures

Reporting bias or same-source bias can occur when neighbourhood conditions are reported by the same respondents for whom outcomes are measured, or in the case of parents, who report characteristics of their children. Same-source bias was a potential problem in several of the reviewed studies on children's socio-emotional outcomes and also studies on maternal mental health (Gorman-Smith et al., 2000; Kowaleski-Jones, 2000; Christie-Mizell et al., 2003; Kotchick et al., 2005; Mulvaney and Kendrick, 2005; Romano et al., 2005; Barnes and Cheng, 2006; Meltzer et al., 2007; Lima et al., 2010; Renzaho and Karantzas, 2010; Sanson et al., 2011; Eriksson et al., 2012; Singh and Ghandour, 2012).

Measures that do not rely on aggregated responses from individuals, such as community surveys or direct observations e.g. of signs for neighbourhood disintegration are valuable alternatives (Mair et al., 2008). Among the reviewed studies, interviewer observations and community surveys have also been used frequently, especially to investigate children's socio-emotional development (Greenberg et al., 1999; Kohen et al., 2002; Drukker et al., 2003; Curtis et al., 2004; Xue et al., 2005; Edwards and Bromfield, 2009; Odgers et al., 2009).

There was a suggestion that statistically significant associations were found more often when neighbourhood factors were measured subjectively, using information provided by the study participants.

2.3.1.4 Measures of institutional resources

One of the consistent findings of this review was the advantage of neighbourhood affluence. A possible explanation is that more affluent neighbourhoods have better institutional resources. While hypothesised as one of the underlying mechanisms through which neighbourhood advantage or disadvantage might affect children's development, the availability and quality of institutions was however rarely measured. Only six of the studies on cognitive outcomes did measure aspects of the school, and all of these found evidence for school effects. Because school factors were not examined in studies on emotional and behavioural problems, their potential contribution to these outcomes remains unknown.

Further, the research by Leckie (2009) and Rasbash et al. (2010) has highlighted the distortion of estimates of neighbourhood variance in multilevel models of cognitive test performance if the school context is not taken into account. While between-neighbourhood variability is likely to be overestimated if estimated on its own, both school and neighbourhood together account for more variability than only one of these contexts alone, which means the overall contextual variability in cognitive outcomes is underestimated in a two-level model.

2.4 How do neighbourhoods affect children's lives? Hypothesised pathways

The three systematic reviews (Jencks and Mayer, 1990; Leventhal and Brooks-Gunn, 2000; Sampson et al., 2002) have provided useful categories regarding the pathways through which neighbourhoods might operate. These can be applied also to the studies that followed. This section identifies three possible pathways that are testable and consistent with the reviewed literature.

1. Social processes

The first hypothesis is that both mothers and children are directly influenced by social processes within the neighbourhood, which have been conceptualised as norms and collective efficacy (Sampson et al., 2002). Collective norms were shown to affect parenting practices (Frech and Kimbro, 2011). Thus, it can be hypothesised that neighbourhoods are spaces that shape parent's behaviour.

Living in a neighbourhood that is perceived to be safe, friendly and well looked after will generate a sense of security and enhance emotional well-being. Experiencing disorder and lack of safety might potentially lead to increased stress levels and symptoms of depression. Some studies found that children's own perceptions of their neighbourhood were related to their emotional well-being and behaviour (Shumow et al., 1998; Guerra et al., 2003; Meltzer et al., 2007; Eriksson et al., 2012). Further, there is evidence in the reviewed literature that mothers living in poor neighbourhoods which are perceived as unsafe are disproportionately affected by psychological distress (Cutrona et al., 2000; Hill and Herman-Stahl, 2002; Barnes et al., 2010).

2. Relationships: Expanding the family stress model

Following from the above, another hypothesis is that children are affected also indirectly by neighbourhood stressors via the psychological health of their mothers, which in turn might lead to less favourable parenting practices.

While the here reviewed research is inconsistent regarding pathways via maternal distress and parenting practices, it has been shown elsewhere that maternal depression and parenting behaviour are strongly related especially with regards to negative maternal behaviour (Lovejoy et al., 2000). There is also strong evidence that chronic maternal depression has negative effects on children's cognitive performance (Hay and Kumar, 1995; Sharp et al., 1995; Petterson and Albers, 2001; Cornish et al., 2005), and behaviour (Alpern and Lyons-Ruth, 1993; Beck, 1999). Recent studies using data from the Millennium Cohort Study also demonstrated links between maternal depression and behavioural problems in children at age three, and with both cognitive and social development at age five, which were mediated in part by parenting practices and the quality of the mother-child relationship (Kiernan and Huerta, 2008; Mensah and Kiernan, 2009).

The family stress model (Figure 2-2), which has been tested and validated in different populations, describes the pathways between material disadvantage, maternal mental health, parenting practices and child outcomes (Conger et al., 1994; Linver, Brooks-Gunn and Kohen, 2002). Here, the family stress model is expanded to incorporate stressors at the neighbourhood level (Figure 2-3). It is hypothesised that the choices a family is able to make with respect to their neighbourhood will be determined by their income, while neighbourhood social processes will affect maternal emotional health and in turn her ability to parent, eventually influencing children's social and cognitive development.

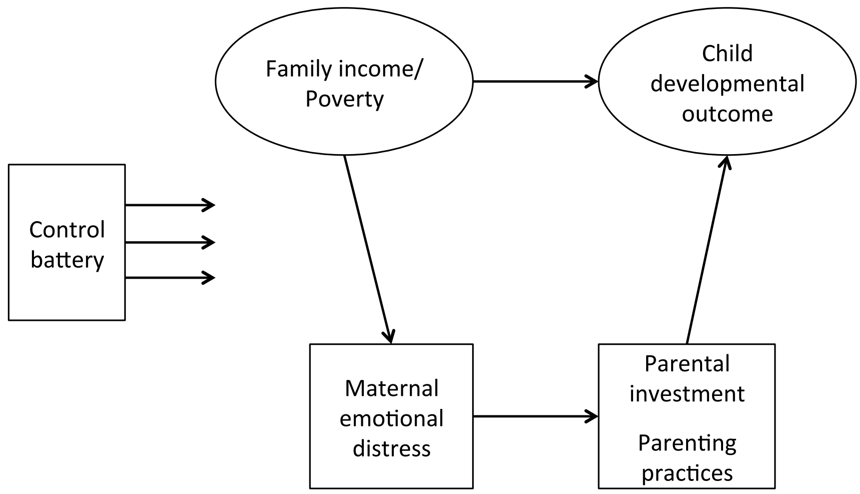

Figure 2-2 The family stress model[1]

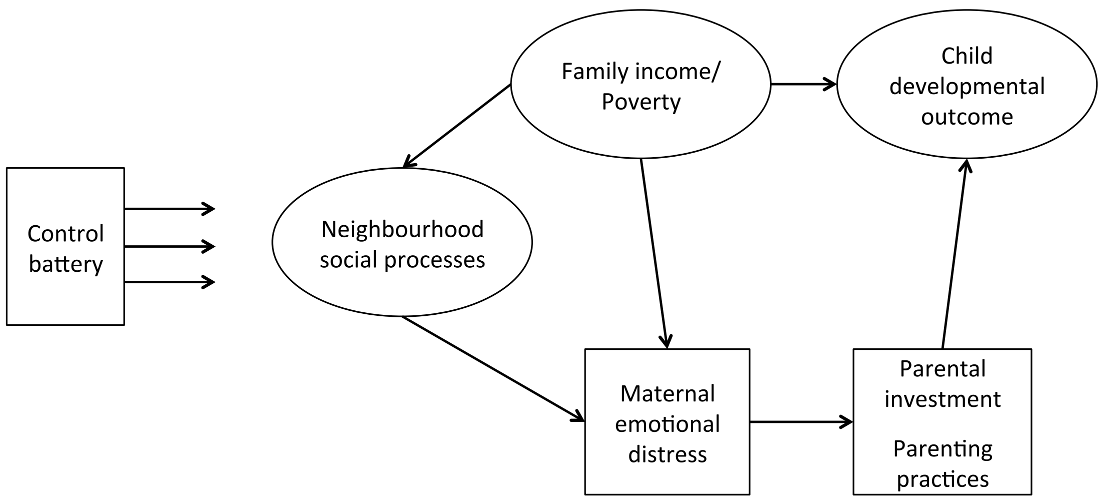

Figure 2-3 An expanded family stress model incorporating neighbourhood social processes[1]

[1] Adapted from: Linver, M. R., Brooks-Gunn, J. and Kohen, D. E. (2002): Family processes as pathways from income to young children's development.

3. Schools

The third hypothesis is that schools play a substantial role for children's cognitive as well as socio-emotional development. Schools can be thought of as part of the neighbourhood effect, as children's place of residence will determine school choices for most. The contribution of schools has been considered in very few of the reviewed studies, but the results suggest that the school environment might be more important for cognitive outcomes than other neighbourhood factors (Leckie, 2009; Rasbash et al., 2010). Especially compelling are the findings on the Harlem Children's Zone schools which were tailored to the needs of disadvantaged children and produced very good results (Dobbie and Fryer, 2011). The consistent finding among the reviewed studies that neighbourhood structural advantage measured via neighbourhood income is related to better cognitive outcomes might also point towards schools as the mediating factor in these relationships.

Only one study had measured a school aspect (maternal perception of school quality) in relation to child behaviour and found an independent association between the two (Kowaleski-Jones, 2000). It is hypothesised that schools play a role also for children's emotional well-being and behaviour.

2.5 Summary

Bronfenbrenner's ecological model of human development postulates that early experiences are shaped by interactions with the immediate as well as the wider environment, and that the different spheres of influence are interrelated, leading to direct and indirect effects. The review of the literature on neighbourhoods and children's socio-emotional and cognitive development has largely supported this view. While the family as the most direct influence is undoubtedly the most important determinant of healthy development, this review found a large body of research showing that children's lives are influenced also by where they live. However, there was also some conflicting evidence regarding the role of neighbourhood deprivation for children's socio-emotional development, as well as regarding the potential mechanisms at play.

Three influential reviews have outlined the possible pathways through which neighbourhood effects are thought to work: norms and collective efficacy, relationships and institutional resources. The research published since 1998 lends empirical support to all of these, albeit to differing degrees. The role of social processes for children's socio-emotional development has been generally supported, however there is considerable uncertainty regarding a mediating role of maternal mental health and parenting, as few studies attempted to disentangle mediation and confounding. For cognitive outcomes, studies have mainly looked at the effects of neighbourhood disadvantage and affluence, largely supporting independent relationships especially for measures of affluence. However, the associations with maternal mental health and parenting are even less clear for children's cognitive skills.

The availability and quality of institutional resources featured rarely in the reviewed literature, but there is some emerging evidence that school choice might play an important role for children's cognitive development. Only two studies have considered neighbourhoods and schools simultaneously, and together with the findings from experimental studies, the results point towards a promising route for further research.

The main limitations of the reviewed studies are data constraints regarding available covariates, issues with same-source bias and for some, the definition of neighbourhood boundaries. Also, few studies have so far been conducted on UK data, and it needs to be tested whether the findings from other countries hold true in the UK context.

To summarise the main gaps in current knowledge, one unresolved question is the role of maternal mental health, as findings have so far been inconsistent. What is missing are studies which examine the whole pathway from neighbourhood exposure via maternal mental health and parenting to child outcomes.

Another question which has been understudied is the role of institutional resources, in particular the contribution of schools to the neighbourhood effect. The two important studies which have estimated the variability in cognitive outcomes between neighbourhoods and schools had only limited access to potential confounding variables (Leckie, 2009; Rasbash et al., 2010). And, neighbourhoods and schools have not yet been examined simultaneously in relation to children's emotional well-being and behaviour.

Further, while there is a general assumption that neighbourhoods might affect boys and girls differently, there is currently no consensus how potential effects play out in relation to gender.

This thesis attempts to address these questions. The full project aims and objectives are outlined in the following chapter.

Chapter 3

Project aims and conceptual model

3 Project aims and conceptual model

3.1 Project aims and objectives

The review of the literature has shown that neighbourhood deprivation as well as affluence are associated with children's socio-emotional and cognitive development. But apart from a well supported pathway via social norms and collective efficacy in relation to behavioural outcomes, the mechanisms underlying these associations are still very much a "black box". The general aim of this research was twofold: to investigate the extent to which place of residence contributes to differences in cognitive and socio-emotional outcomes among children from a large representative UK sample, and to explore two specific pathways through which such place effects might operate. One hypothesis is that neighbourhood characteristics affect children via maternal psychological distress and parenting. Another hypothesis is that schools contribute to the variability in children's socio-emotional and cognitive outcomes across neighbourhoods. The specific aims and objectives of this thesis were as follows:

Aim 1: To examine whether the neighbourhood context influences levels of maternal psychological distress and parenting practices.

Objectives

1.1. To determine the variability of maternal psychological distress between neighbourhoods.

1.2. To examine whether neighbourhood characteristics and maternal neighbourhood perceptions contribute to levels of maternal distress, over and above family socio-economic background.

1.3. To examine the variability of parenting practices between neighbourhoods and to test whether maternal psychological distress mediates the relationship between neighbourhood characteristics and aspects of parenting.

The analyses and results pertaining to Aim 1 can be found in chapter six. Neighbourhood characteristics were measured at sweep two (child aged three). Levels of maternal psychological distress were measured when the child was three (cross-sectional analysis) and seven years old (longitudinal analysis). Parenting behaviours were measured when the child was aged three.

Aim 2: To examine the relative importance of neighbourhoods and schools for children's socio-emotional development.

Objectives

2.1. To partition the variability in socio-emotional difficulties at age seven between families, neighbourhoods and schools.

2.2. To examine whether neighbourhood and school characteristics contribute to socio-emotional difficulties, over and above family socio-economic background.

2.3. To test whether maternal psychological distress and parenting practices are on the pathway between neighbourhood characteristics and children's socio-emotional difficulties.

2.4. To test whether associations vary by family income and child gender.

The results relating to Aim 2 are presented in chapter seven. Neighbourhood characteristics were measured at sweeps two and four. The outcome variables were measured at sweep four, when the child was seven years old.

Aim 3: To examine the relative importance of neighbourhoods and schools for children's cognitive development.

Objectives

3.1. To partition the variability in cognitive test performance at age seven between families, neighbourhoods and schools.

3.2. To examine whether neighbourhood and school characteristics contribute to cognitive test performance, over and above family socio-economic background.

3.3. To test whether maternal psychological distress and parenting practices are on the pathway between neighbourhood characteristics and children's cognitive test outcomes.

3.4. To test whether associations vary by family income and child gender.

The results of the analyses corresponding to Aim 3 can be found in chapter eight. Again the neighbourhood characteristics were measured at sweeps two and four and outcome variables were measured at sweep four.

3.2 Conceptual model and research hypotheses

The conceptual model in Figure 3-1 shows the hypothesised pathways subject to investigation in the analyses chapters. The proposed framework is an adaptation and extension of the family stress model (Linver et al., 2002), additionally incorporating neighbourhood and school influences. Factors that are thought to operate at more proximal levels are depicted further towards the right hand side.

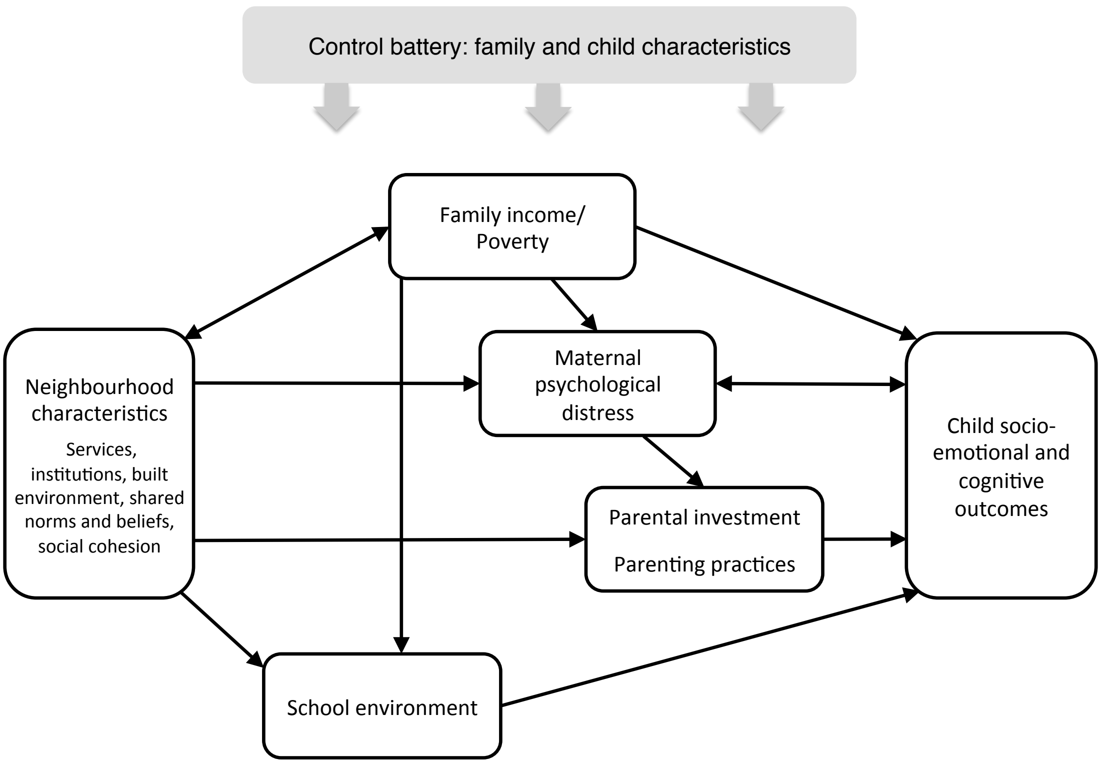

Figure 3-1 Conceptual model (adapted from Linver et al., 2002)

It is hypothesised that family income in the form of material hardship will affect maternal levels of distress and child outcomes directly and also the residential choices available to the family - therefore the arrow towards neighbourhood characteristics. The degree to which mothers are happy and feel safe within their neighbourhood environment will affect their levels of psychological distress, which in turn will influence their ability to invest in parenting behaviours such as the provision of learning opportunities, structures and routines. Aspects of parenting might also be directly influenced via shared norms and beliefs within the neighbourhood, or by perceptions of danger which might then be associated with harsher parenting strategies. While family income is assumed to also affect parenting investments directly, this pathway is outside the focus of this research. The model recognises that the relationship between maternal psychological distress and children's behavioural development is likely to be bidirectional.

Neighbourhood, i.e. place of residence is also assumed to influence children's behaviour and cognition via the school choices that are available within their locality.

Regarding these pathways, two research hypotheses will be specifically tested.

Research hypothesis 1:

Maternal psychological distress and parenting practices are on the pathway between neighbourhood characteristics and children's socio-emotional, as well as cognitive outcomes.

Research hypothesis 2:

The variability in children's socio-emotional and cognitive outcomes at age seven that can be measured between neighbourhoods is in part due to variability between schools.

Chapter 4

Data

4 Data

This research is based on the secondary analysis of longitudinal data from the Millennium Cohort Study (MCS). The MCS is housed by the Centre for Longitudinal Studies (CLS) at the Institute of Education, University of London. Access to the data is provided through the UK Data Service at the University of Essex[1]. Additional data were derived from the Census Dissemination Unit (CDU) and linked into the MCS dataset. This chapter presents an overview of the Millennium Cohort Study as well as a detailed description of all variables that were used in the analyses.

4.1 The Millennium Cohort Study

The Millennium Cohort Study (MCS) is one of the UK longitudinal cohort studies. It is a nationally representative study that at the first sweep included 18,818 children from 18,552 families who were born at the beginning of the new century in the four countries of the UK (Plewis, 2007a). The MCS is a rich dataset that enables insights into many aspects of children's lives and development, with an emphasis on the social and economic contexts in which children grow up. The data include measures of children's socio-emotional and cognitive development, maternal psychological well-being, parenting practices, maternal perceptions as well as interviewer systematic observations of the neighbourhood, and a whole range of family socio-economic background characteristics. It is one of the stated aims of the MCS "to investigate the wider social ecology of the family, including social networks, civic engagement, community facilities and services; splicing in geo-coded data when available" (Hansen et al., 2012), thus making it a suitable source for the study of neighbourhood effects.

At the time of writing, data were available from the first four sweeps of the study, collected when the children were 9 months, 3 years, 5 years, and 7 years old. While the analyses make use of information from all sweeps, outcomes were measured only at sweep two (maternal psychological distress and parenting) and sweep four (maternal psychological distress, children's socio-emotional difficulties and children's cognitive test performance).

[1] Neither the CLS nor the UK Data Service bear any responsibility for the analysis or interpretation of the data.

4.1.1 MCS sample design

The MCS children were born over a period of two years: between September 2000 and August 2001 in England and Wales, and between November 2000 and January 2002 in Scotland and Northern Ireland (NI).

The sample is geographically clustered and stratified to over-represent areas of high child poverty, areas with high proportions of ethnic minorities in England and also the three smaller countries of the UK (Hansen et al., 2012). The sampling frame was the electoral ward, that means all children who were born in the selected wards during the specified timeframe were eligible to take part in the study. The children were found using Child Benefit Records.

There are nine strata from which electoral wards were sampled at the first sweep. A summary of the MCS design strata, number of wards sampled and final sample size is given in Table 4-1. The numbers are reproduced from the “Technical report on sampling” (Plewis, 2007a). Wards were classified as “disadvantaged” if they were among the poorest 25% of wards, based on the Child Poverty Index, and “ethnic” (applicable in England only) if at least 30% of the population were Black or Asian (Hansen et al., 2012).

Table 4-1 MCS sample size and number of sampled wards by stratum within country, sweep one

Country	Stratum	Number of wards in stratum	Final sample size
England	Advantaged	110	4,687
	Disadvantaged	71	4,592
	Ethnic	19	2,416
Wales	Advantaged	23	844
	Disadvantaged	50	1,954
Scotland	Advantaged	32	1,163
	Disadvantaged	30	1,207
Northern Ireland	Advantaged	23	735
	Disadvantaged	40	1,220
Total		398	18,818

MCS sample sizes and attrition

The achieved sample size at sweep one was 18,552 households, which corresponds to an overall response rate of 72% (Plewis, 2007a). At sweep two, families in England who had been eligible but could not be contacted at the first wave were invited to enter the study. This resulted in 631 new families joining the study at sweep two (Hansen et al., 2012). The achieved sample sizes for all sweeps are shown in Table 4-2.

Table 4-2 MCS sample sizes[1]

Sweep	N (children)	N (families)
MCS 1	18,818	18,552
MCS 2	15,808	15,590
MCS 3	15,459	15,246
MCS 4	14,043	13,857

4.1.2 Interview

The MCS questionnaires were delivered via structured interviews during home visits, using Computer Assisted Personal Interviewing (CAPI). A self-completion part included sensitive topics such as questions regarding the child’s temperament and behaviour, the respondent’s mental health and relationships with the child and partner (where present). The interviewers also took anthropometric measurements of the child (for parents, self-reported measures were recorded), and from sweep two administered cognitive assessments to the children. Figure 4-1 gives an overview of the survey content at each sweep.

[1] Source: Hansen, K., Johnson, J., Joshi, H. et al. (2012): Millennium Cohort Study: First, Second, Third and Fourth Surveys. A Guide to the Datasets (Seventh Edition).

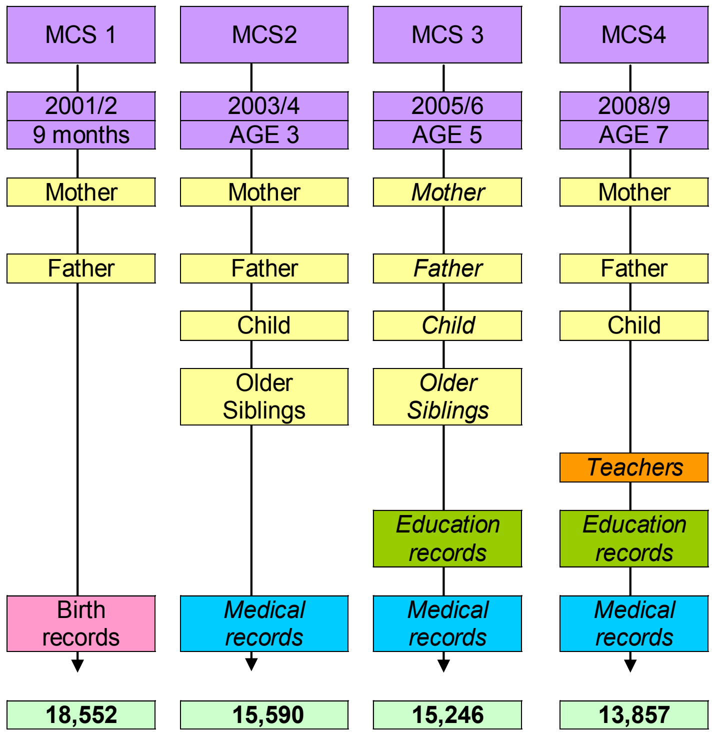

Figure 4-1 MCS survey content at each sweep[1]

4.2 Neighbourhood definition

This project used both administrative and subjective neighbourhood definitions. To calculate the amount of between-neighbourhood variability in the outcomes of interest, a neighbourhood definition was needed which corresponded to meaningful administrative boundaries and for which geographical identifiers were available. These identifiers were also needed to link neighbourhood data from other sources into the MCS dataset.

4.2.1 Overview of UK geographies

Local statistical information has traditionally been released at the electoral ward or division level. As well as being subject to regular changes, wards vary greatly in size with populations from fewer than 100 up to more than 30,000. To improve the reporting of small area population estimates, the Office for National Statistics (ONS) developed new geographies for England and Wales in 2004: the Super Output Areas (Office for National

[1] Source: Hansen, K., Johnson, J., Joshi, H. et al. (2012): Millennium Cohort Study: First, Second, Third and Fourth Surveys. A Guide to the Datasets (Seventh Edition).

Statistics, 2012b). Super Output Areas are built from groups of 2001 Census Output Areas and are designed to be comparable and stable with consistent population sizes (Office for National Statistics, 2011). For Scotland and Northern Ireland, similar geographies were introduced, however there are differences in terms of population sizes. The available geographies for the four UK countries are detailed below and summarised in Table 4-3.

England and Wales

For England and Wales, two levels of Super Output Areas have been designed: Lower Layer Super Output Areas and Middle Layer Super Output Areas.

Lower Layer Super Output Areas (LSOAs) contain a minimum of 1,000 residents (400 households), and their average population size was 1,500 at the 2001 census. There are 34,378 LSOAs in England and Wales. LSOAs were constructed electronically from Output Areas, taking into account population size and social homogeneity, with homogeneity criteria relating to type of dwelling and housing tenure (Office for National Statistics, 2012b).

Middle Layer Super Output Areas (MSOAs) are built from clusters of LSOAs. At the 2001 census, MSOAs had a minimum population of 5,000 with an average of 7,200. In England and Wales there are 7,194 MSOAs.

Scotland

For Scotland, equivalent geographies to LSOAs and MSOAs are the Data Zones and Intermediate Geographies (Inter Zones). Data Zones are slightly smaller than LSOAs with a population of 500 – 1,000 residents, and were designed to represent natural communities. Inter Zones are aggregations of Data Zones and have populations of 2,500 to 6,000 (The Scottish Government, 2012).

Northern Ireland

For Northern Ireland, Super Output Areas (SOAs) have been created. These are slightly larger than LSOAs, with a population size of 1,300 to 2,800 (Northern Ireland Statistics and Research Agency, 2012). There is no geographical unit in Northern Ireland that corresponds to MSOAs. Closest in size to MSOAs are electoral wards, however these vary substantially in size.

Table 4-3 Super Output Areas and their equivalents for each UK country

Country	Lower level	Next higher level
England and Wales	Lower Layer Super Output Area Minimum population size: 1,000 Average: 1,500	Middle Layer Super Output Area Minimum population size: 5,000 Average: 7,200
Scotland	Data Zone Population between 500 and 1,000	Inter Zone Population between 2,500 and 6,000
Northern Ireland	Super Output Area Population between 1,300 and 2,800	Electoral ward Population from 800 to >9,000

4.2.2 Choice of administrative neighbourhood boundaries

Previous UK research has shown that administrative boundaries can be good approximations of "neighbourhood" when compared with boundaries based on physical attributes such as street patterns (Stafford, Duke-Williams and Shelton, 2008). For the purpose of this research, neighbourhoods were defined as Lower Layer Super Output Areas (LSOAs) in England and Wales, Data Zones in Scotland and Super Output Areas in Northern Ireland [1]. These boundaries were chosen because they are designed to be socially homogeneous, their size corresponds well to the concept of "neighbourhood" and because they are reasonably comparable across the UK countries, i.e. are considered to have the same meaning on the ground. Where data was aggregated, it was done at these levels.

Access to small area level geographical identifiers is restricted for reasons of confidentiality. For this project, an application was made to the Economic and Social Data Service to use LSOA identifiers, which was granted under Special License.

The figures below show mapped examples of an electoral ward (Figure 4-2), Middle Layer Super Output Areas (Figure 4-3) and Lower Layer Super Output Areas (Figure 4-4) in the London Borough of Lewisham (Source: Office for National Statistics licensed under the Open Government Licence v.1.0)[2]. Area boundaries are marked by dark blue lines. The map scale is about 1: 20,000. One centimetre on the map approximates 200 metres.

[1] From here onwards, the term "LSOAs" is used to include Scottish Data Zones and NI Super Output Areas.

[2] © Crown copyright and database rights (2012) Ordnance Survey 100019153

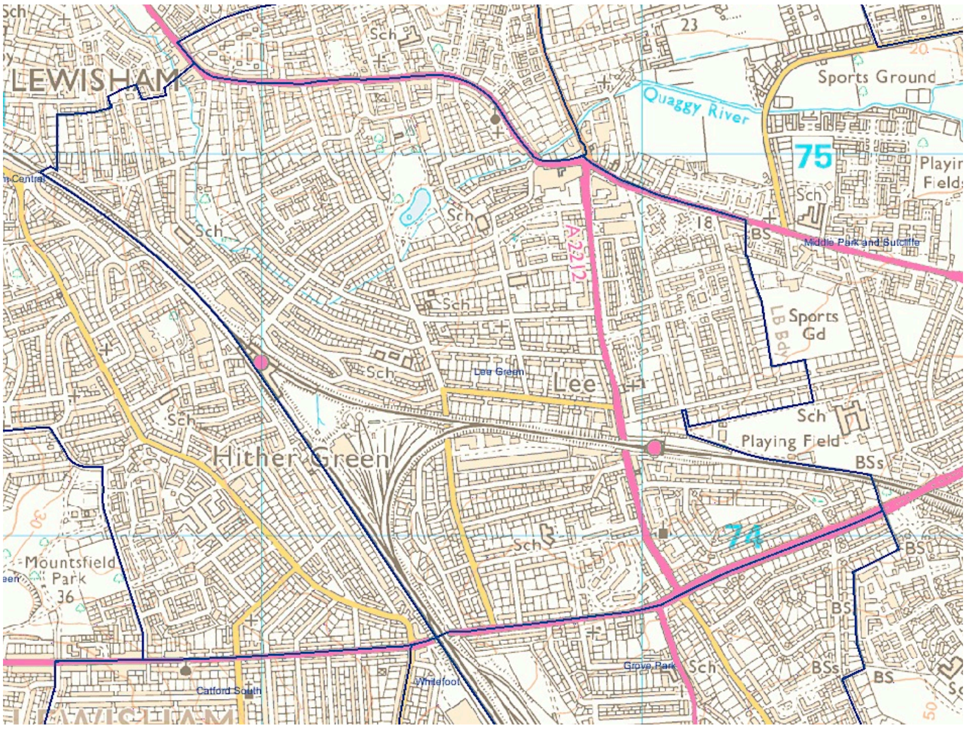

Figure 4-2 Electoral ward (London, Lewisham)

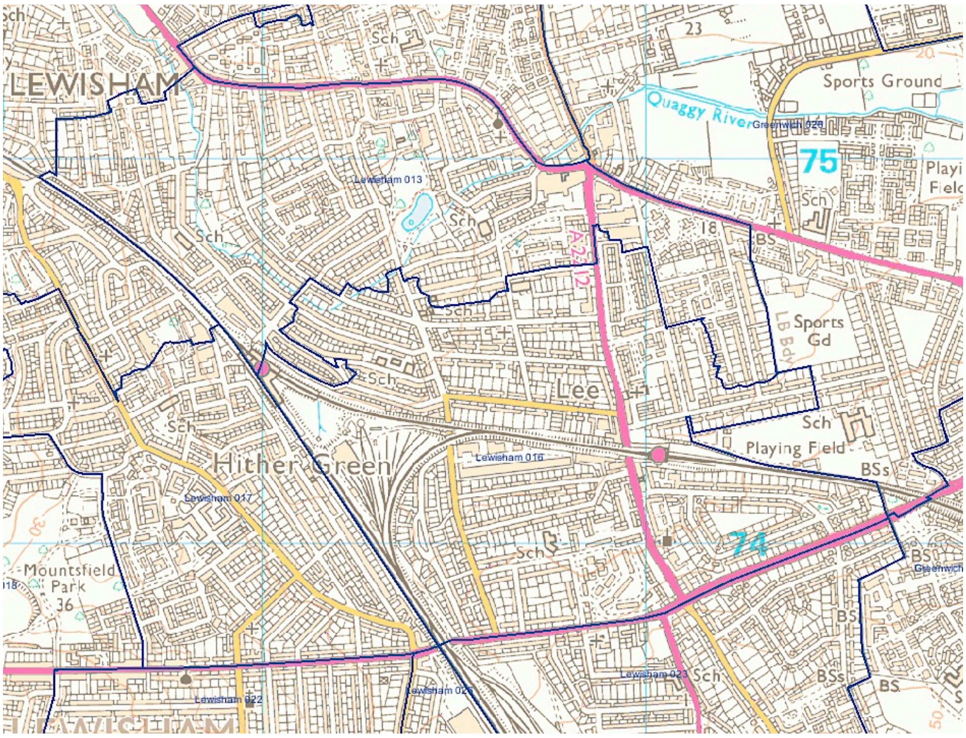

Figure 4-3 Middle Layer Super Output Areas (London, Lewisham)

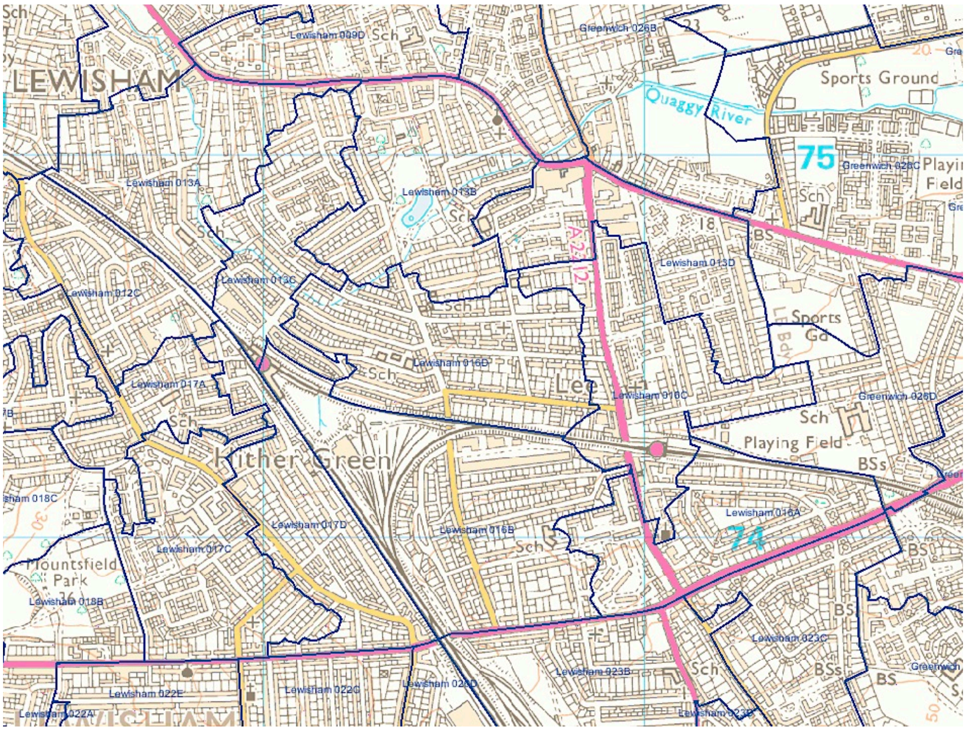

Figure 4-4 Lower Layer Super Output Areas (London, Lewisham)

4.3 Neighbourhood and school characteristics

While neighbourhood structural measures such as deprivation indices and median household income were available for each sweep of the MCS, the questions that have been put to the survey respondents were different at each sweep, as will be described in the following sections.

4.3.1 Structural/compositional measures

The structural and compositional measures used in the analyses were the Indices of Multiple Deprivation (IMD), neighbourhood median household income, the percentage of households in the neighbourhood living in social housing and a rural/urban indicator. The IMD and rural/urban indicators are provided within the MCS as “geographically linked data”. Neighbourhood median household income and percentage of social housing in the neighbourhood are available via the Census Dissemination Unit (CDU) and were downloaded from Casweb, a free service for members of UK higher education establishments. These data were linked into the dataset using the geographical identifiers at LSOA level.

4.3.1.1 Index of Multiple Deprivation (IMD)

Linked into the MCS data are IMD rank deciles for each UK country. Indices of deprivation are available for all UK countries and are produced to identify deprivation at the small area level. The English Index of Multiple Deprivation is made up of seven domain indices: income deprivation; employment deprivation; health deprivation and disability; education, skills and training deprivation; barriers to housing and services; living environment deprivation; and crime. The living environment domain consists of two indicators: a measure of the “indoors” environment (private and social housing in poor condition and houses without central heating) and a measure of the “outdoors” environment (air quality and road accidents involving injury to pedestrians and cyclists). The ranking is based on an weighted cumulative model of these domains (Noble et al., 2008). The indices for the other UK countries were constructed in a similar way. The rank deciles for each UK country were combined into a single variable[1].

Education, Skills and Training Deprivation Domain of the IMD

The analysis of neighbourhood effects on children’s cognitive outcomes (chapter eight) uses the education, skills and training deprivation domain of the IMD as a single variable. The English indicator consists of two subdomains, one that captures education deprivation for children and young people, and one relating to skills and qualifications in adults. The education deprivation subdomain includes average point scores from Key Stages 2 to 4, pupil absences, the proportion of young people not staying in school level education after reaching the age of sixteen, and the proportion of those under the age of 21 not entering higher education. As such, it is a proxy measure of local school performance and intake. The adult skills subdomain relates to the proportion of working age adults with no or low qualifications (Noble et al., 2008). The education domains of the IMD for Wales, Scotland and NI are based on almost identical measures (Social Disadvantage Research Centre, 2003; Northern Ireland Statistics & Research Agency, 2005; Statistics for Wales, 2008)

[1] This means that the combined measure was still a measure of relative deprivation. For example, a family who was in the top (= least deprived) decile in Northern Ireland was sorted into the top decile of the combined variable, irrespective of the absolute level of deprivation.

4.3.1.2 Neighbourhood median household income

The review of the literature suggested that measures of neighbourhood affluence might be as important for children's socio-emotional and cognitive outcomes as measures of deprivation. Therefore, a measure of neighbourhood median household income was considered as an exposure variable in the analyses.

Data on median household income at LSOA level is available to UK academics via the CDU Casweb website. The data are estimates for the entire UK and are provided by Experian, an information services company. Experian uses census data, survey data and their own Mosaic Public Sector classification system to predict the likely household income at an address (Experian, 2011). The Mosaic system is itself modelled using census data as well as a large number of data items from market research and public sector datasets, including demographics, consumption, financial measures and property values (Experian, 2009). The data are regularly updated. Used here were 2004 estimates for MCS sweep two outcomes and 2008 estimates for MCS sweep four outcomes.

The distribution of the sweep four variable was positively skewed (longer right tail), and the interquartile range lay between approximately £17,500 and £30,000 (Figure 4-5). The measure was used in the analyses as a continuous variable.

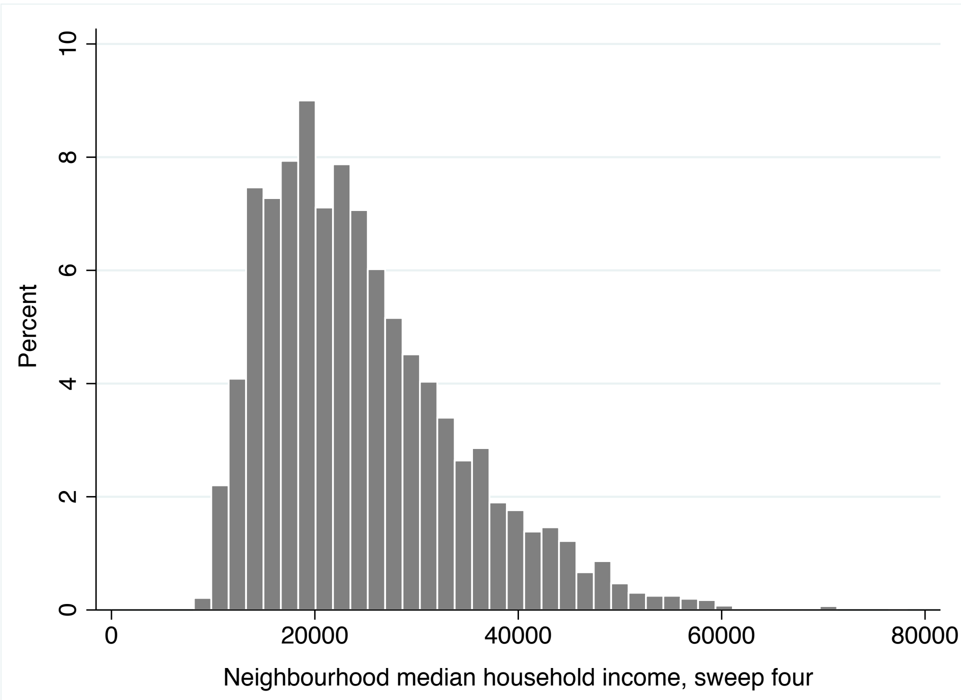

Figure 4-5 Histogram of median household income at sweep four (N= 13,222)

4.3.1.3 Percentage of households in the neighbourhood living in social housing

The percentage of households in the neighbourhood living in social housing, i.e. renting from the local authority or a housing association, was derived from 2001 census data[1], also available via the Census Dissemination Unit (Office for National Statistics, 2001). Figure 4-6 shows a histogram of the variable distribution at sweep four, which was also positively skewed with a high percentage of zeros.

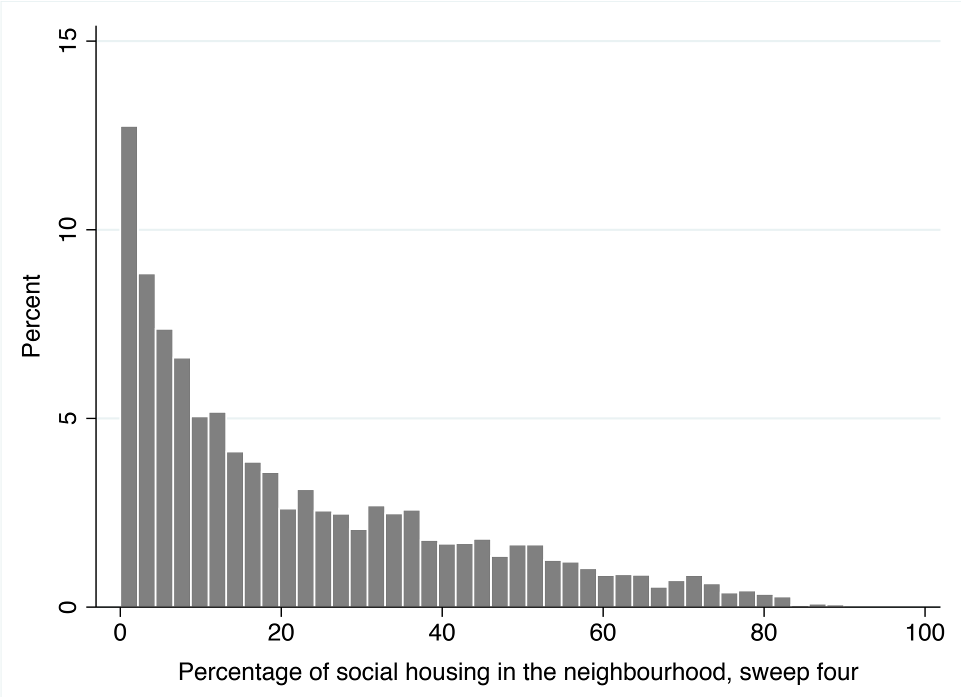

Figure 4-6 Histogram of the percentage of social housing in the neighbourhood at sweep four (N= 13,222)

4.3.1.4 Rural Urban indicator

An indicator of rural versus urban settlements was also considered, whereby localities with a population size of more than 10,000 were defined as “urban” (Office for National Statistics, 2012a). The Rural Urban indicator is part of the “geographically linked data” file that is provided together with the MCS survey data.

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[1] Copyright Statement: Census output is Crown copyright and is reproduced with the permission of the Controller of HMSO and the Queen's Printer for Scotland.

4.3.1.5 School fee-paying status

The only school level variable that was available within the dataset was whether school fees were applicable. While the teacher survey that was conducted at sweep four contained for example questions on class size and time spent on homework, a large percentage of observations for these items was missing (e.g. more than 60% for class size), and it was therefore decided not to use them. Another variable that was considered but not used was whether the parents had to demonstrate their religious faith to obtain a place at the school, because the question had not been asked of respondents in Northern Ireland and the variable had no independent explanatory power for the here examined child outcomes.

4.3.2 Maternal neighbourhood perceptions and systematic interviewer observations

Measures of maternal neighbourhood perceptions and interviewer observations were collected at sweep two. These included items such as feelings of safety and physical signs of neglect such as litter, graffiti and run-down buildings, and can be seen as tapping into the norms/collective efficacy theme identified by the review of Leventhal and Brooks Gunn (2000). At sweep four there was no such information available, however mothers were asked whether there were parks and playgrounds in the area and whether they had friends or family in the neighbourhood.

4.3.2.1 Mothers' satisfaction with the neighbourhood (sweep two)

At sweep two, mothers were asked the following three questions relating to their area, which was defined as "within about a mile or 20 minutes walk".

- How satisfied or dissatisfied are you with the area you live in?
  (Very satisfied; Fairly satisfied; Neither satisfied nor dissatisfied; Fairly dissatisfied; Very dissatisfied)
- Is this a good area to bring up children?
  (Excellent; Good; Average; Poor; Very poor)
- Which of these phrases best describes how safe you feel in the area you live in?
  (Very safe; Fairly safe; Neither safe nor unsafe; Fairly unsafe; Very unsafe)

These items were highly correlated, and were combined using Principle Components Analysis (PCA), resulting in a single component or factor score. The factor loadings and Cronbach's Alpha statistic are shown in Table 4-4. The items tap into an underlying construct which can be described as "neighbourhood satisfaction". The Cronbach's Alpha statistic was 0.84, indicating good internal consistency.

Table 4-4 Maternal neighbourhood satisfaction at sweep two – PCA

Items	**Factor loadings**	**Uniqueness**
Satisfaction with area	0.88	0.23
Good area to bring up children	0.90	0.19
How safe feels in area	0.84	0.30
Variance proportion explained		76%
Cronbach's Alpha		0.84

4.3.2.2 Systematic interviewer observations (sweep two)

The MCS features systematic interviewer observations of the street the child lived in, which were conducted at sweep two, when the child was three years old. Highly correlated items were again combined via Principal Components Analysis to form a factor score. The items included in the score were:

- Is there any of the following: rubbish, litter, broken glass, drug related items, beer cans etc., cigarette ends or discarded packs – in the street or on the pavement?
  (None or almost none; Yes some; Yes just about everywhere you look)
- How would you rate the general condition of most of the residences or other buildings in the street?
  (Well kept, good repair & exterior surfaces; Fair condition; Poor condition, peeling paint, broken windows; Badly deteriorated)
- Is there any graffiti on walls or on public spaces like bus shelters, telephone boxes or notice boards?
  (No; A little; A lot)

- Do any of the fronts of residential or commercial units have metal security blinds, gates, or iron bars & grilles?
  (None; Some; Most)
- How did you feel parking, walking, and waiting at the door in the street?
  (Very comfortable – can imagine living/shopping here; Comfortable – a safe and friendly place; Fairly safe and comfortable; I would be uncomfortable living/working/shopping here; I felt like an outsider looked on suspiciously; I felt afraid for my personal safety).

The underlying construct might be described as “observed neighbourhood disorder”. The items loading on this factor and Cronbach’s Alpha are shown in Table 4-5. The Cronbach’s Alpha statistic for this measure was 0.77.

Table 4-5 Interviewer observed neighbourhood disorder at sweep two – PCA

Items	**Factor loadings**	**Uniqueness**
Litter etc. in the street or on the pavement	0.81	0.35
General condition of buildings in the street	0.62	0.61
Graffiti on walls or on public spaces	0.78	0.40
Security blinds	0.72	0.49
How did you feel in street	0.83	0.31
Variance proportion explained		57%
Cronbach’s Alpha		0.77

4.3.2.3 Having friends and family in the area (sweep four)

The question “Do you have any friends or family living in this area?” was asked at sweep four. Possible answers were “Yes, friends”, “Yes, family”, “Yes, both” and “No”. While not strictly a measure of neighbourhood perception, the item is potentially an indicator of mothers’ sense of belonging and their local social network. It was converted into a binary variable and coded as “1” if the mother had neither friends nor family in the neighbourhood.

4.3.2.4 Availability of parks and playgrounds (sweep four)

At sweep four, respondents were also asked "Are there any parks, playgrounds or public spaces in this area where (the child) can play outdoors (either on his/her own or supervised)"? Possible answers were "Yes" and "No" [1].

4.3.2.5 Deriving aggregated scores and weighted quintiles

Deriving aggregated scores

For the analyses in chapter six, maternal neighbourhood perceptions were not only used as individual-level variables but were also aggregated over neighbourhoods to minimise the potential influence of same-source bias. This was done by computing the mean score for each LSOA (and their respective equivalents in Scotland and NI), using the full sweep two sample. The average number of observations per LSOA was 3.0, ranging from 1 to 43.

Deriving weighted quintiles

For the neighbourhood satisfaction and interviewer observation scores, variables of weighted quintiles were created using the user-written Stata command -quantiles- (Osorio, 2007). All variables of quintiles were derived from the data of the full sweep one and sweep two samples, and were computed using the overall survey weight for the respective sweep. The difference between Stata's -quantiles- and -xtile- commands is that -quantiles- defines categories by the ideal size of the quantile, so that the resulting categories are more equal in size.

4.3.3 Correlations between contextual measures

Tables 4-6 and 4-7 show Pearson's correlation coefficients for the contextual measures at sweeps two and four. All correlations were highly statistically significant. The IMD deciles were coded so that higher values represented less deprivation. Higher values for the maternal neighbourhood dissatisfaction scores represented less neighbourhood satisfaction, and higher values for interviewer observed disorder represented more disorder. The IMD was highly correlated with median neighbourhood income and the

[1] At sweep four, mothers were also asked whether the child was allowed to play outside unsupervised. The variable was however dropped from the analysis because it was not clear what it was measuring. Playing outside unsupervised at the age of seven was independently associated with higher average socio-emotional difficulties. Presumably, the variable was meant to measure parents' confidence in the safety of the outside environment, but it might be that in children of this age it measured some form of uninvolved parenting.

percentage of social housing in the neighbourhood, while the correlation between median income and social housing was moderate. Maternal dissatisfaction and interviewer observed disorder were correlated moderately with each other as well as with the structural neighbourhood measures, in the expected directions.

Table 4-6   Correlations between contextual measures at sweep two (child aged 3)

	IMD	Median income	% Social housing	Maternal dissatisfaction	Observed “disorder”
IMD	1.00				
Median income	0.75	1.00			
% Social housing	-0.72	-0.60	1.00		
Maternal dissatisfaction	-0.43	-0.32	0.39	1.00	
Observed “disorder”	-0.57	-0.46	0.47	0.43	1.00

Table 4-7   Correlations between contextual measures at sweep four (child aged 7)

	IMD	IMD education domain	Median income	% Social housing	Rural versus urban	No friends/ family	No parks/ playgrounds
IMD	1.00						
IMD education domain	0.86	1.00					
Median income	0.65	0.68	1.00				
% Social housing	-0.73	-0.67	-0.54	1.00			
Rural versus urban	0.24	0.26	0.06	-0.20	1.00		
No friends and family in the area	-0.05	-0.04	-0.02	0.04	-0.03	1.00	
No parks/ playgrounds	-0.10	-0.09	-0.14	0.04	0.05	0.04	1.00

4.4 Maternal psychological distress and parenting practices

4.4.1 Maternal psychological distress

Maternal psychological distress was investigated first as a stand-alone outcome variable and in subsequent analyses as a potential mediator in the relationship between neighbourhood characteristics and the child outcomes.

From sweep two to sweep four of the MCS, maternal psychological distress was measured via the same instrument, the Kessler-6 scale[1]. The Kessler-6 scale was the outcome variable in chapter six (measured both at sweep two and sweep four) and used as a mediator variable in chapters seven and eight.

The Kessler-6 scale

The Kessler-6 is an instrument with very good internal consistency as well as accuracy in predicting serious mental illness (Kessler et al., 2003). It consists of six questions asking how often in the past 30 days the respondent had felt:

- So depressed that nothing could cheer you up
- Hopeless
- Restless or fidgety
- That everything you did was an effort
- Worthless
- Nervous?

The questions form a 24-point scale. For each question respondents score four points if they answer “all of the time”, three points for “most of the time”, two points for “some of the time”, one point for “a little of the time” and zero for “none of the time” (Hansen and Joshi, 2007). A histogram of the scale using sweep two data is shown in Figure 4-7. The distribution was positively skewed, with almost 25% of mothers scoring zero points.

[1] At sweep one, maternal distress was measured via the Rutter Malaise Inventory, which was not used here.

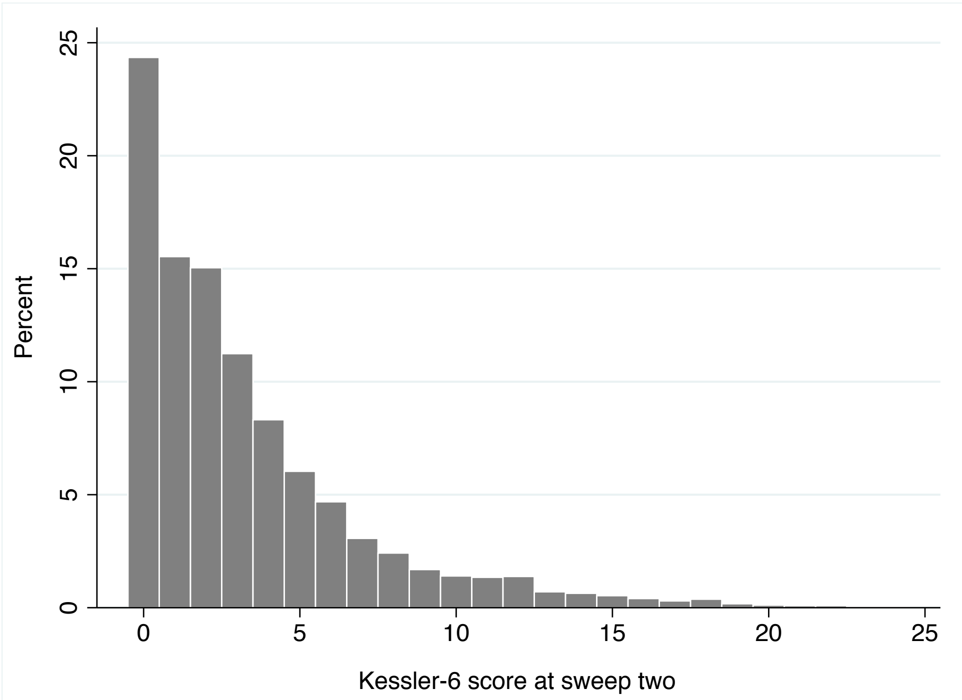


Figure 4-7 Histogram of Kessler-6 scores at sweep two (N= 13,410)

In all multilevel regression analyses the scale was used as a continuous measure. For descriptive analyses the scale was converted into a categorical variable. The cut-offs used were 0-3 for no distress, 4-12 for moderate distress and 13 or over for severe distress (Kessler et al., 2003; Calderwood, Kelly and Panico, 2007).

For the longitudinal analyses in chapters seven and eight, a measure of chronic maternal distress was used. The variable was constructed to indicate whether the mother had experienced any distress (had a score higher than 3) either never, in the past only (at sweep two and/or sweep three), concurrently (at sweep four only, or at sweep four and one earlier sweep), or persistently (at sweeps two, three and four).

4.4.2 Parenting practices

As with maternal psychological distress, parenting practices were examined as outcome variables (chapter six) and as mediator variables (chapters seven and eight). The MCS contains rich data on parenting behaviours, parenting style and the home environment parents provide for their children, all of which are thought to be important for children's cognitive as well as social development. However, it would have been impractical to analyse all of these measures. One option would have been to derive a score by summing up positive items related to the home learning environment, as has been done elsewhere (Dearden et al., 2011). However, this was deemed unsatisfactory because a score would give the same weight to each item, and it is questionable whether e.g. activities such as reading to the child and taking the child to the library are equally important (the same reasoning applies for different measures of harsh parenting). Here, it was decided to select four examples of parenting behaviours. These were daily reading, regular bedtimes, the use of smacking and daily shouting.

Daily reading and regular bedtimes were chosen as examples for activities and family routines because their importance for children's cognitive and socio-emotional development has been demonstrated (Melhuish et al., 2008b; Kelly, Kelly and Sacker, 2011a; Kelly et al., 2011b). For reading, respondents were also asked whether anyone else reads to the child. However, only mother-reported daily reading was used here because the focus of the research was whether parenting practices such as reading are influenced by levels of maternal psychological distress[1].

It has been suggested that harsh parenting practices are linked to negative perceptions of the neighbourhood (Earls et al., 1994; Leventhal and Brooks-Gunn, 2000), however some studies did not find such associations (Pinderhughes et al., 2001; Ceballo and McLoyd, 2002). The use of smacking and daily shouting were examined as examples of harsh parenting to test this hypothesis.

The four parenting behaviours are listed in Table 4-8. All items were measured at sweep two (child age three). To be used as outcome measures they were converted into binary variables.

[1] In most families where the father or partner reported to read daily, the mother read daily as well. In less than 3% of all families at sweep two was the father but not the mother reporting to read daily to the child.

Table 4-8   Variables on parenting style / home environment, sweep two

Variable	Categories
Daily reading	Mother reads to the child daily
	Mother does not read daily
Regular bedtime	Mother reports that the child has always/usually a regular bedtime
	Irregular bedtime
Smacking	Mother reports to never smack the child
	Smacking used at all
Daily shouting	Mother reports to shout daily
	Mother shouts less than daily

Correlations between parenting behaviours

Table 4-9 shows the correlations between the four parenting behaviours. Clear but not overly strong correlations were found between the two measures of activities and routines, and between the two measures of harsh parenting.

Table 4-9   Correlations between parenting behaviours at sweep two

	Daily reading	Regular bedtime	Smacking	Daily shouting
Daily reading	1.00			
Regular bedtime	0.17	1.00		
Smacking	-0.10	-0.01[NS]	1.00	
Daily shouting	-0.08	-0.06	0.18	1.00

[NS] Correlation not statistically significant

4.5 Child socio-emotional difficulties at age seven

Children's socio-emotional difficulties at age seven (sweep four) was the outcome variable in chapter seven. It was measured via the Strengths and Difficulties Questionnaire (SDQ), a widely used and validated measure for screening psychiatric disorder (Goodman, 2001). At sweep four of the MCS, when the children were seven years old, the SDQ was completed by the mother as well as by a teacher. Both outcomes were used in the analyses, because it has been shown that measures of child psychopathology are subject to variation between informants (Collishaw et al., 2009). Teacher reports of socio-emotional difficulties were however available only for about two thirds of the overall sample.

The SDQ consists of 25 items, which are divided between the following five scales: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems and pro-social behaviour (Table 4-10). The "Total Difficulties" score is derived from the four negative scales, excluding pro-social behaviour. The score can in theory lie anywhere between 0 (no difficulties at all) and 40 (respondent thinks that the child certainly has difficulties in all areas covered by the questionnaire). In this sample, the range was 0-37 for both mother and teacher reports.

The Total Difficulties score was used in the analyses as a continuous variable, but was for descriptive purposes converted into a binary measure. The cut-points were chosen by identifying the extreme 10% of the sample. These were children who scored 16 or more points on the mother-reported Total Difficulties scale and 15 or more points on the teacher-reported Total Difficulties scale.

Comparison between mother and teacher reports of children's socio-emotional difficulties

Teachers generally gave lower scores than mothers. The overall mean score as reported by mothers was 7.7, while for teachers this was 6.4. Histograms of the two variables reveal that the distribution of teacher-reported scores was more heavily skewed right with a higher percentage of zeros (Figures 4-8 and 4-9). The correlation coefficient for mother- and teacher-reported total difficulties was 0.47, based on 8,207 children for whom both measures were available. This only moderate correlation means that mothers and teachers did not necessarily identify the same children as having behavioural or emotional problems.

Table 4-10 The Strengths and Difficulties Questionnaire

The respondent was asked to answer the following statements with: “not true” (0 points), “somewhat true” (1 point) or “certainly true” (2 points).

Emotional problems	**Conduct problems**	**Hyperactivity/ Inattention**	**Peer problems**	**Pro-social behaviour**
Complains of headaches/ stomach-aches/ sickness	Often has temper tantrums	Restless, overactive, cannot stay still for long	Tends to play alone	Considerate of others’ feelings
Often seems worried	Generally obedient*	Constantly fidgeting	Has at least one good friend*	Shares readily with others
Often unhappy	Fights with or bullies other children	Easily distracted	Generally liked by other children*	Helpful if someone is hurt, upset or ill
Nervous or clingy in new situations	Can be spiteful to others	Can stop and think before acting*	Picked on or bullied by other children	Kind to younger children
Many fears, easily scared	Often argumentative with adults	Sees tasks through to the end*	Gets on better with adults	Often volunteers to help others
Total difficulties				

***Reverse coded**

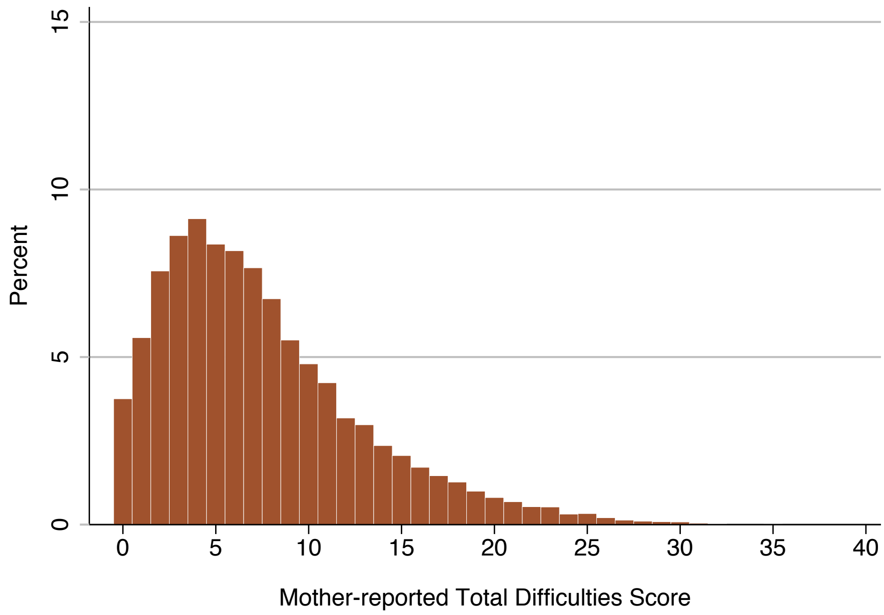


Figure 4-8 Histogram of mother-reported Total Difficulties scores at sweep four (N= 12,766)

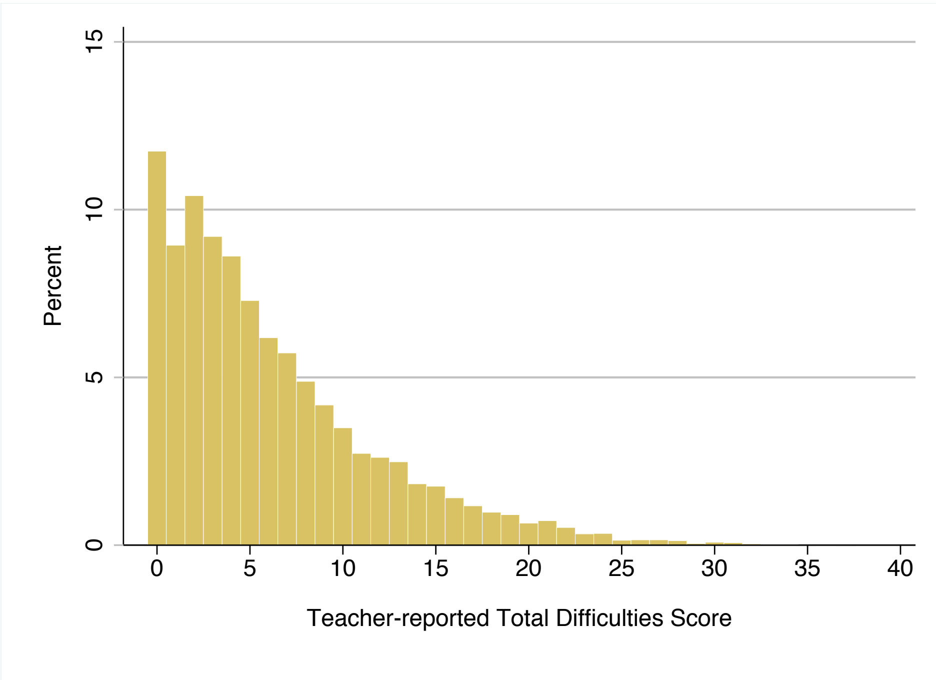


Figure 4-9 Histogram of teacher-reported Total Difficulties scores at sweep four (N= 8,382)

4.6 Child cognitive test performance at age seven

Three measures of cognitive ability that are available at age seven (sweep 4) were used here: the Word Reading and Pattern Construction subscales of the British Ability Scales (BAS) and a Number Skills test. Interviewers were trained to ensure a standardised procedure, and contextual factors such as distractions or interruptions that could have influenced the child's performance were recorded (Hansen, 2010). All three tests are adaptive: in the number skills test the child is routed to easier, medium and harder sections based on an initial subtest, and the BAS subscales use decision points and alternative stopping points to steer the child towards items that are most suitable for their ability and to protect self-esteem and motivation (Hill, 2005). The tests consist of the following:

BAS Word Reading: The child reads out words that are presented on a card. The variable used in the analysis is the standardised age-adjusted score.

BAS Pattern Construction: The test is a measure of spatial visualisation ability and does not require verbal skills (Hill, 2005). The child is asked to construct a pattern using coloured squares or cubes, and scores are based on accuracy and speed (Hansen, 2010). The variable used is the standardised age-adjusted T-score.

Number Skills: The Number Skills test has been adapted from the "Progress in Maths" test, which was developed by the National Foundation for Educational Research. It assesses children's ability to solve mathematical tasks and includes concepts such as shape, space and measures (Hansen, 2010). The variable used here is the standardised age adjusted score, which was supplied by the Centre for Longitudinal Studies on request.

Standardising the scores

To enable meaningful comparisons between the three cognitive outcomes, the standardised scores were converted into z-scores using (unweighted) sample means and standard deviations. The z-scores have a mean of zero and were scaled to have a standard deviation of 100; therefore the estimates can be interpreted as percentages of a standard deviation (%SD). Histograms of the three cognitive outcomes are shown in Figures 4-10 to 4-12. The measures were fairly normally distributed.

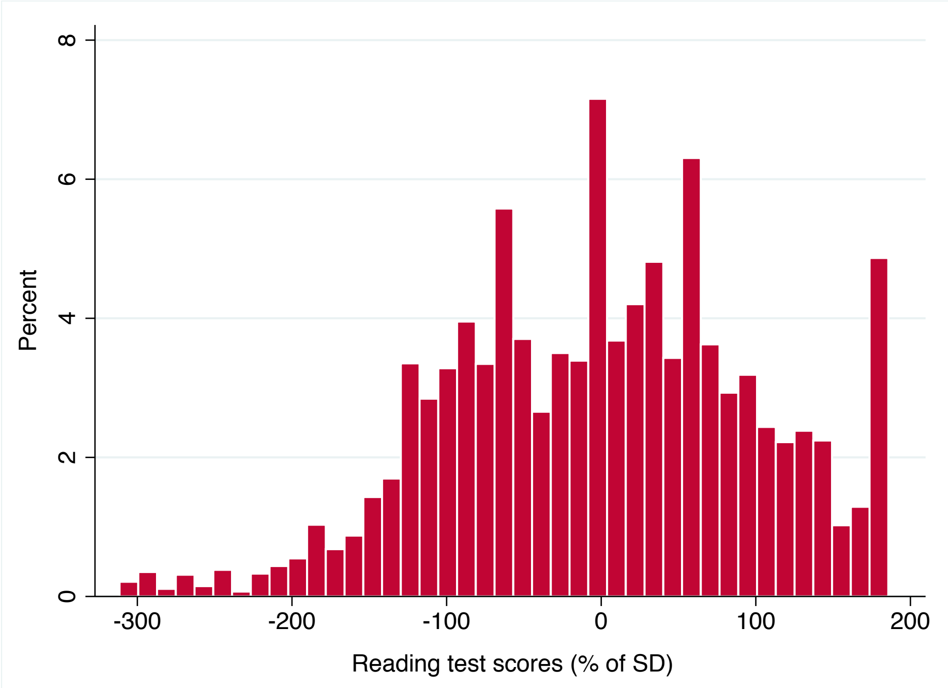


Figure 4-10 Histogram of reading test scores at age 7 (sweep four)

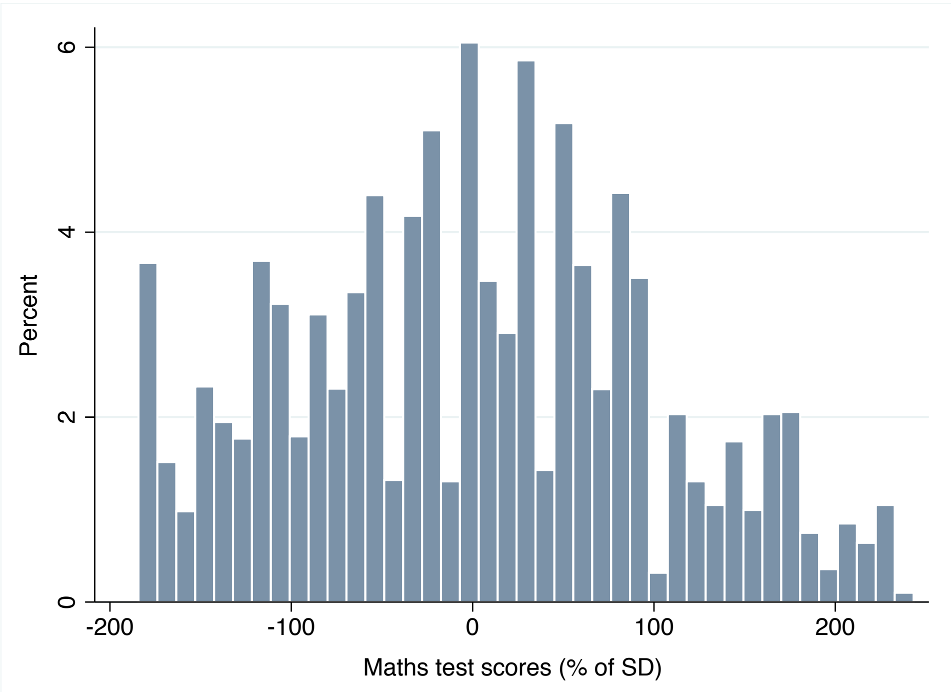


Figure 4-11 Histogram of maths test scores at age 7 (sweep four)

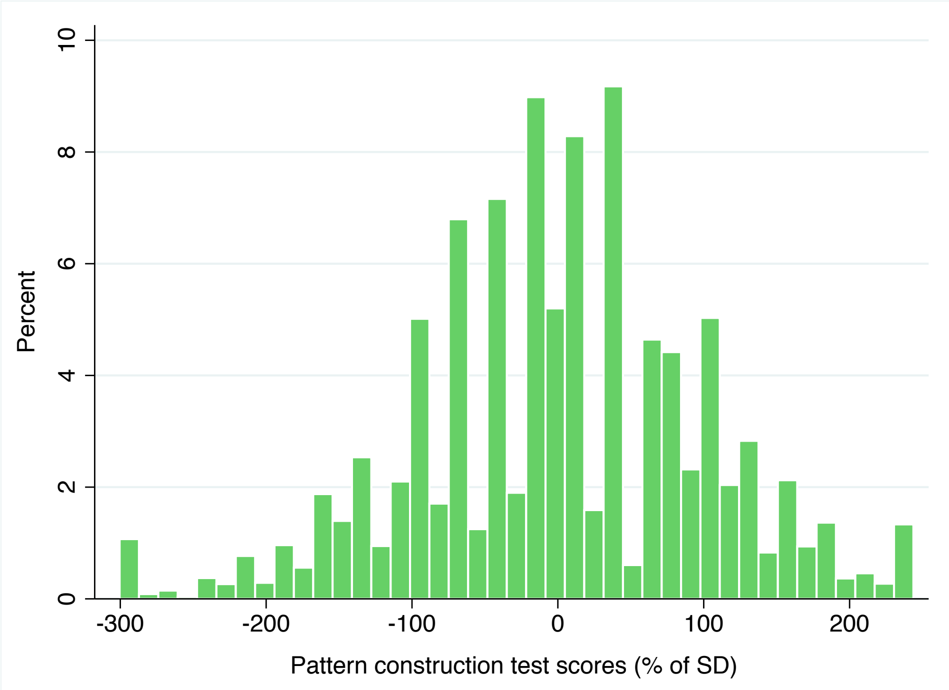


Figure 4-12 Histogram of pattern construction test scores at age 7 (sweep four)

Correlations between cognitive test scores

Table 4-11 shows the correlations between the three cognitive test scores. The scores were moderately correlated, however the correlation between reading and pattern construction test performance was less strong.

Table 4-11 Correlations between cognitive test scores, sweep four

	Reading	Maths	Pattern construction
Reading	1.00		
Maths	0.51	1.00	
Pattern construction	0.32	0.47	1.00

4.7 Covariates – family socio-demographic background

The associations between neighbourhood characteristics, maternal distress and parenting were examined using sweep two as well as sweep four data. For these analyses, the relevant covariates were taken from sweeps two and four (chapter six). For the analyses of children's socio-emotional difficulties and cognitive test performance (chapters seven and eight), all covariates stemmed from sweep four, when the outcomes were measured.

4.7.1 Child characteristics

All full regression models pertaining to the child outcomes (chapters seven and eight) adjusted for children's sex, age, ethnicity and SEN status.

Child age

Child age is given in the dataset in days. In the models, it was scaled to months for ease of interpretation, using the conversion of 1 month = 30.417 days.

Child ethnicity

Ethnicity was included in the analyses because it is known that ethnic minority families cluster within neighbourhoods, and that cognitive test performance varies by ethnicity (Dearden and Sibieta, 2010). The following eight categories were used in the analyses: White; Mixed; Indian; Pakistani; Bangladeshi; Black Caribbean; Black African; and Other.

SEN status (special educational needs)

All models pertaining to the child outcomes included a measure of whether the child had been identified by the school as having special educational needs (reported by the mother). This was done because it might be that some schools have a higher intake of children with SEN than others, which could have led to an overestimation of between-school differences.

4.7.2 Maternal and family characteristics

Maternal age

For descriptive purposes, maternal age was categorised into age groups, but in the regression analyses it was used as a continuous variable (unit = years). Maternal age was also examined as a quadratic term to ascertain whether associations were curvilinear.

Maternal ethnicity

Maternal ethnicity was used as a covariate in the analyses in chapter six, where the outcomes were maternal psychological distress and parenting practices. The same eight-category classification was used as for the measure of child ethnicity.

Family structure

Family structure was a categorical variable with three categories: both natural parents, mother living with a partner other than the natural father, and single mother.

Family income

This was a continuous measure of OECD equivalised weekly family income, scaled so that one unit represented £100 per week. For descriptive analyses, the measure was categorised into quintiles.

Social class

Social class was measured via the National Statistics Socio-economic Classification (NS-SEC). The NS-SEC measures employment relations and conditions, including authority and control at work (Office for National Statistics, 2013). The categories used here are shown in Table 4-12. For two-parent families, the variable was coded according to the partner with the higher social class.

Housing tenure

Housing tenure was included in the models because it is a measure of family socio-economic background, as well as potentially being associated with neighbourhood perceptions. The categories are listed in Table 4-12.

Maternal education

Maternal education was measured via mothers' highest qualification level, which is a combined measure of academic and vocational qualifications. The categories are described also in Table 4-12.

Number of children in the household

This measure included the number of all children belonging to the household.

Whether family moved before sweep three

It has been recently reported that frequent residential moves are associated with emotional problems in young children (Rumbold et al., 2012; Flouri, Mavroveli and Midouhas, 2013). The child outcomes were examined using analysis samples of children who lived in the same area since at least sweep three. However, a binary measure of whether the family had moved to a different neighbourhood prior to sweep three was included in the analyses of children's socio-emotional difficulties.

Table 4-12 Maternal and family socio-economic background variables, sweep four

Variable	Categories
Maternal education (National Vocational Qualifications or NVQ)*	• Level 4/5 (Degree / Higher Degree) • Level 3 (2+ A-levels) • Level 2 (5 GCSE A-C / 1 A-level) • Level 1 (< 5 GCSE D-E) • Overseas qualification only • None
Parental social class (NS-SEC mother or partner, whichever was higher)	• Managerial and professional • Intermediate • Small employer and self-employed • Lower supervisory and technical • Semi-routine and routine • No parent in work (single mother not in work or both partners not in work) or no occupation reported
Housing tenure	• Owned/mortgaged accommodation • Rented privately • Social housing (includes renting from local authority and renting from housing association) • Other (includes living with parents)

* Source: (Hansen et al., 2010)

4.8 Who lives where?

An important issue to consider is the extent to which neighbourhood and family socio-economic characteristics overlap by looking at neighbourhood composition at different levels of deprivation.

Figure 4-13 shows the average income distribution within neighbourhoods by IMD decile for the sweep four sample, which is the sweep when the child outcomes were measured. Almost 80% of families living in the most deprived neighbourhoods belonged to the bottom and second fifth of the income distribution. Note that all families in the bottom fifth and half of the families in the second fifth met the definition of relative poverty, that is, were living on incomes below 60% of the median of the population. The percentage of income-poor families fell steeply as neighbourhood deprivation decreased. When looking at these distributions the other way around, it is also true that only half of the poorest families (defined as living in relative poverty) lived in the 20% most deprived areas, while the other half did not. Similar estimates have been reported also for different sources of data (Joshi et al., 2000; Melhuish and Hall, 2007).

However, in the MCS less than 5% of all families affected by relative poverty lived in the least and second least deprived neighbourhoods. In absolute numbers, these were less than 200 income-poor families out of the 3,900 in the sample.

In summary, while the vast majority of families living in the most deprived areas were poor, being poor and living in a poor area are two separate factors that do not necessarily go hand in hand. However, poor families living in the least deprived neighbourhoods were rare. This is important to bear in mind when trying to make inferences as to whether children from poor backgrounds would fare better were they living in rich neighbourhoods.

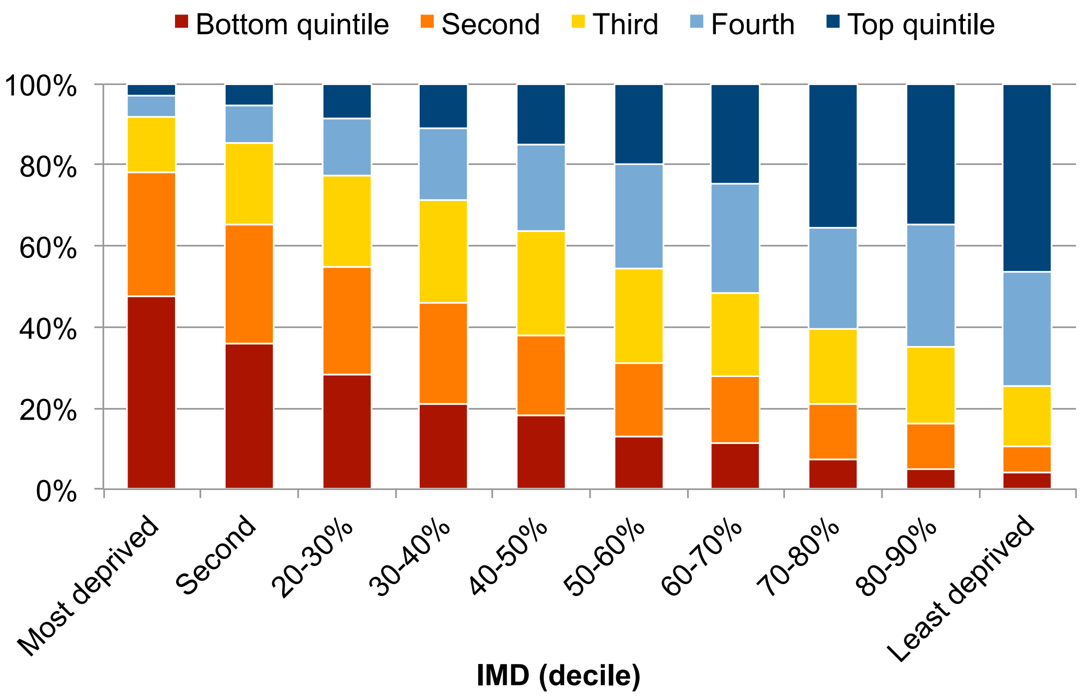


Figure 4-13 Neighbourhood composition (family income quintiles), by IMD decile, sweep four

4.9 Analysis samples and missing data

All analyses are based on complete cases. This section describes the sample sizes for the different analyses that have been undertaken as well as the patterns of missing data and the characteristics of families for whom data was missing.

4.9.1 Defining the analysis samples

Across all analyses, observations where the main respondent was the father or other relative were excluded. This was because the role of maternal psychological distress was one of the central research questions. Also excluded were multiple births, because it is known that the here examined outcomes are moderated by multiple gestation pregnancies (The ESHRE Capri Workshop Group, 2000).

When researching the effects of place there is the question what the time length of exposure might be that is needed for the place to exert an influence on the individual. Of course, this might depend on the type of place as well as a host of other factors that are unknown. For families who had moved shortly before the data collection it was assumed that the influence of their current neighbourhood would have been smaller than would be the case if they had spent time there for longer, thus leading to an underestimation of the overall variance in the outcome that was due to differences between neighbourhoods. The same reasoning applies to the length of time spent in a given school.

Data were analysed cross-sectionally and longitudinally. The cross-sectional analyses included only families who had lived in the same neighbourhood[1] at least since the previous sweep (or for two years). It is however acknowledged that this cut-off is arbitrary. For the analyses of the child outcomes, children were also excluded if they had changed schools since the previous sweep. Longitudinal analyses included families who had lived in the same neighbourhood between sweeps two and four, i.e. at least for four to five years.

The sample sizes for the different analyses and how they were arrived at are presented in Table 4-13. The cross-sectional analyses of neighbourhood effects on maternal psychological distress and parenting were based mainly on data from sweep two, while the cross-sectional analyses of the child outcomes used mainly data from sweep four of the study. As mentioned in section 4.5, teacher reports of children's socio-emotional difficulties were available only for a subsample of all children, therefore the sample sizes in chapter seven are not the same for the mother-reported and teacher-reported outcomes. For the cognitive outcomes, only children who completed all three tests were included in the final analysis sample to enable direct comparisons between the three measures.

[1] Families who had moved house but stayed within the same neighbourhood were kept in the analysis samples.

Table 4-13 Analysis samples

	Maternal distress and parenting (chapter 6)	Socio-emotional development (chapter 7)		Cognitive development (chapter 8)
		Mother-reported	Teacher-reported	
Sweep at which the outcome was measured	Sweep two	Sweep four	Sweep four	Sweep four
Original sample size	15,590	13,857	8,876	13,857
Sample after excluding multiple births and observations where the respondent was not the natural mother	15,077	13,222	8,412	13,222
Sample after excluding families who had not been residentially stable, and children who had changed school (chapters 7 and 8)	10,441	10,651	6,807	10,651
Cross-sectional analysis sample after excluding observations with missing data	**7,766**	**9,840**	**6,450**	**9,412**
Longitudinal analysis sample after excluding observations with missing data	**7,387**[1]	**6,668**	**4,414**	**6,524**

[1]Outcome measured at sweep four

Characteristics of families who were not residentially stable

Table 4-14 compares characteristics of families who were included in the analyses to those of families who were excluded because they had not lived in the same neighbourhood between sweeps three and four, or because the children had changed schools. The table shows that families who had not been residentially stable were on average more disadvantaged and had less favourable outcomes, which might have led to more conservative results.

Table 4-14 Comparison between families who were / were not residentially stable since sweep three (sweep four data)

	Residentially stable (N= 10,651)	Not residentially stable (N= 2,571)
Outcome variables		
Mothers with Kessler-6 score >3 (%)	30.8	37.8
Children with socio-emotional difficulties, mother report (%)	8.7	13.9
Mean reading test score	4.4	-6.4
Mean maths test score	1.2	-8.1
Mean pattern construction test score	0.1	-7.3
Covariates		
Mean maternal age (years)	36.1	34.1
Mean family income per week (pounds)	398.5	368.5
Families in relative poverty (%)	27.3	34.7
Families in social housing (%)	23.7	27.8
Mothers with NVQ level 4/5 (%)	36.4	32.1
Mothers with no qualifications (%)	11.0	12.3
Mother ethnic minority (%)	12.0	12.0
Single mothers (%)	20.1	30.1

4.9.2 Missing data

Non-response or attrition is a ubiquitous issue for longitudinal studies. Missing data can also be the result of item non-response, when participants refuse to answer some of the questions. Here it is assumed that data is “Missing At Random”. Under the “Missing At Random” assumption non-respondents and respondents do differ systematically, but the missingness depends on the observed data and can therefore be predicted and accounted for in the analysis (Carpenter, Bartlett and Kenward, 2012).

Item non-response at sweeps two and four

Most missingness occurred in the outcome variables, while missingness in covariates was less of an issue (the only exception being the family income variable at sweep two). The extent of item non-response at sweeps two and four for the variables that have been used in the analyses is shown in Appendix II (Tables 11-4 and 11-5). Under Missing At Random, there is little benefit in imputing the outcome if the missingness in the independent variables is sparse (Little, 1992). Also, the focus of this project was on examining associations as opposed to estimating population averages. It was therefore deemed acceptable to perform a complete case analysis with these data.

Characteristics of families with missing data

The characteristics of families with complete data versus families with missing data in any of the outcomes or covariates at sweep four are shown in Table 4-15. Families with missing data were on average more disadvantaged and had poorer outcomes. For example, while about 28% of families with complete data were living in relative poverty, this was true for 46% of families for whom some data was missing. The missingness is likely to have led to results that were more conservative.

Table 4-15 Comparison between families without/with missing data in any of the outcomes or covariates, sweep four

	Families with complete data (N= 11,721)	Families with missing data[1] (N= 1,501)
Outcome variables		
Mothers with Kessler-6 score >3 (%)	31.7	34.1
Children with socio-emotional difficulties, mother report (%)	8.8	15.4
Mean reading test score	1.8	-19.8
Mean maths test score	3.4	-32.0
Mean pattern construction test score	2.6	-25.8
Covariates		
Mean maternal age (years)	36.0	35.8
Mean family income per week (pounds)	395.6	279.6
Families in relative poverty (%)	27.5	45.7
Families in social housing (%)	21.8	30.4
Mothers with NVQ level 4/5 (%)	38.6	27.8
Mothers with no qualifications (%)	8.9	28.0
Mother ethnic minority (%)	11.3	36.0
Single mothers (%)	20.8	22.4

[1] Does not include families for whom the teacher-reported SDQ was missing.

4.10 Ethical considerations

Ethical approval has been granted for each sweep of the MCS, and informed consent has been obtained from parents prior to any data collection (Hansen et al., 2012).

Data protection is the primary ethical issue that arises from secondary analysis of existing data. Responsible for confidentiality of the data is the Centre for Longitudinal Studies (CLS), which houses the MCS. The datasets are fully anonymised and freely available for academic use from the UK Data Service.

As mentioned above, geographical identifiers at the small area level have been made available for this project by the Economic and Social Data Service (now integrated into the UK Data Service) under Special License. The use of these data is subject to special conditions to protect the confidentiality of the data.

Chapter 5

Methods

5 Methods

This chapter describes in general the statistical methods that were used in the analyses. The analytical strategies and concrete model specifications that were employed to achieve the research aims are outlined at the beginning of the relevant results chapters (chapters six to eight).

5.1 Descriptive analyses

Descriptive analyses were carried out using Stata version 12.1 (Statacorp., 2011), using all available information. The distribution of outcome variables was explored via cross-tabulations by family socio-demographic background, neighbourhood characteristics and levels of maternal psychological distress where appropriate. Pearson’s correlation tests were conducted to examine which explanatory variables were significantly associated with the outcomes. Chi square tests for trend were computed where appropriate. The Stata survey (-svy-) command containing survey weights was employed when calculating population means and proportions to account for the stratification and geographical clustering of the data. The survey weights also adjust for non-response (Plewis, 2007b; Ketende and Jones, 2011).

5.2 Multilevel models

Multilevel analyses were based on complete cases and were performed using Stata version 12.1 (Statacorp., 2011) and MLwiN version 2.26 (Rasbash et al., 2009).

Multilevel models have been developed to enable the modelling of social contexts (Plewis, 1998). They can be applied when data have a hierarchical or nested structure, for example residents (level one) living in neighbourhoods (level two) which are nested within regions (level three). There are two main advantages over the use of single level models: firstly, members sharing the same context (e.g. a school or neighbourhood) are likely to be more similar to each other. Ignoring the nested structure of the data would therefore lead to an underestimation of standard errors. Secondly, and of particular interest to this research, multilevel modelling techniques simultaneously estimate the variability in the outcomes of interest at the different levels and thus yield information about the contribution of the contextual levels of influence (Plewis, 1998).

Because of the geographical clustering of the MCS data (with the electoral ward as the sampling frame) the data have a hierarchical structure, where children are nested within areas and within schools. The structure of the MCS data therefore lends itself to the use of multilevel modelling techniques.

5.2.1 Fixed effects and random effects

In multilevel models, fixed effects are those that are directly modelled and for which regression coefficients are obtained. A single-level regression model can be thought of as a model of fixed effects. If there are only few groups at the higher level, these can be modelled as fixed effects via a set of dummy variables. For example, if comparisons were to be made only between the four UK countries these could be directly modelled, with each having their own regression coefficient. But, if a sample has many groups at the higher level(s), as is the case for the neighbourhoods and schools in the MCS dataset, this is not feasible. Instead, the variability between these groups can be modelled, which is then referred to as random effects (Plewis, 1998).

Random intercept models are models where only the intercept (the mean) is allowed to vary between the groups (here: neighbourhoods and schools). If there is reason to believe that the strength of the associations (the slope, or steepness of the regression line) varies by some group level characteristic, a more complex model can be estimated where both intercepts and slopes are allowed to vary between groups. This is called a random slopes model or random coefficients model (Plewis, 1998). A hypothetical example would be if the relationship between children's educational attainment and their family's socio-economic background was not the same across schools, but was dependent on a school-level characteristic, for example the financial resources that are available to the school.

It is also possible that the relationship between a neighbourhood-level variable and the outcome depends on an individual-level characteristic (a cross-level interaction), for example the gender of the child. The modelling of cross-level interactions in a random coefficients model is described in section 5.2.8.

Notation for a two-level random intercept model

The notation follows practice at the Centre for Multilevel Modelling at the University of Bristol. Based on the notation for a regression model, a two-level model can be written as

$y_{ij} = \beta_{0j} + \beta_1 x_{ij} + e_{ij}$

$\beta_{0j} = \beta_0 + u_{0j}$

which is the same as

$y_{ij} = \beta_0 + \beta_1 x_{ij} + u_{0j} + e_{ij}$

where $(\beta_0 + \beta_1 x_{ij})$ is the fixed part of the model and $(u_{0j} + e_{ij})$ is the random part, with

y_{ij} = response y for the i^{th} individual in the j^{th} group

β_0 = overall intercept

β_1 = overall slope

β_{0j} = intercept (mean of y) for a given group j

e_{ij} = individual level residuals (difference between y_{ij} and β_{0j})

u_{0j} = group level residuals (difference between β_{0j} and β_0)

x_{ij} = continuous explanatory variable for which values vary between individuals within a group

σ_u^2 = var(u_{0j}) = group level (between group) variance

σ_e^2 = var(e_{ij}) = individual level (within group) variance.

The overall relationship between y and x is a straight line with an intercept β_0 and a slope β_1. In Figure 5-1, the black line is the overall regression line, while the red and blue lines are the regression lines for area 1 (red) and area 2 (blue). The group level residual u_j is the difference between the mean (the intercept) for a given group j and the overall mean, while the individual level residual e_{ij} is the difference between the data point y_{ij} and its group mean.

Both individual-level and group-level residuals are assumed to follow a normal distribution with a mean of zero (Steele and Goldstein, 2007; Steele, 2008).

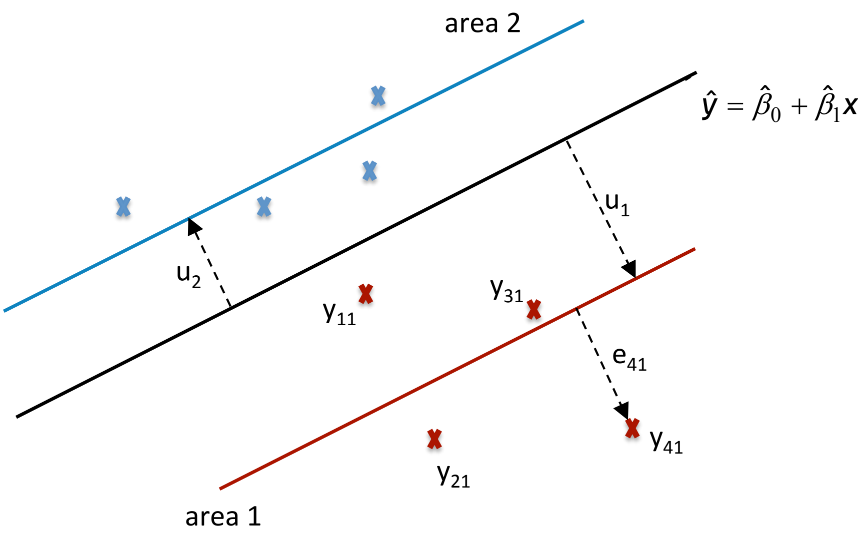


Figure 5-1 Individual- and group-level residuals (adapted from Steele, 2008)

5.2.2 Variance Partition Coefficient

The Variance Partition Coefficient (VPC, or rho) represents the proportion of the variance attributable to factors operating at the higher level, here it is neighbourhoods and schools. The VPC is calculated by dividing the between-group variance by the total variance, where the total variance is the sum of the between-group variance and the within-group variance:

$$\text{VPC } (\rho) = \frac{\text{Between-group variance } (\sigma_u^2)}{\text{Between-group variance } (\sigma_u^2) + \text{Within-group variance } (\sigma_e^2)}$$

5.2.3 Shrinkage

One feature of multilevel models is that the predicted group-level residuals ($\hat{u}_j$) are weighted, that means that the raw residuals are multiplied by a shrinkage factor. The amount of shrinkage depends on the number of observations in the group and on the Variance Partition Coefficient. It is calculated by the formula

$$\text{shrinkage factor (k)} = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2 \ / \ n_j}$$

where n_j is the number of observations in group j. The shrinkage factor can lie between 0 and 1.

The above formula means that the predicted group-level residuals are pulled towards zero (more shrinkage) when the number of observations per group is small (i.e. there is not much information about the group and estimates of group-level residuals are unreliable), and when the group-level variance is small in relation to the individual-level variance. Smaller residuals mean that the predicted group-level intercept will be closer to the overall intercept (shrinkage to the mean). This is sometimes called “borrowing strength”, as for groups with fewer observations the estimation of the group-level intercept relies more on information from other groups (Steele and Goldstein, 2007; Rabe-Hesketh and Skrondal, 2008; Snijders and Bosker, 2011). For a group with only one observation, the shrinkage factor is equal to the VPC.

5.2.4 Interpretation of multilevel models for binary responses

In chapter six, parenting behaviours are examined as binary outcome variables. Binary outcomes can be modelled using multilevel binary response models. In a binary response model the within-neighbourhood variance or level-1 variance is not estimated, because it is assumed to follow a logistic distribution with a mean of zero and a variance of $\pi^2/3$. An approximation to the level-1 variance is therefore fixed at 3.29.

The Variance Partition Coefficient for a binary response model is interpreted as the proportion of the total variance in the propensity to be in response category 1 (versus 0) that is due to differences between groups (Steele, 2008).

5.2.5 Cross-classified multilevel models

Differences in cognitive ability and behaviour vary not only between neighbourhoods but also between schools. The MCS dataset contains anonymised school identifier variables, thus enabling the simultaneous modelling of between-area and between-school variability. A simple three-level hierarchical model would assume that children are nested within schools and schools are nested within areas, as shown in Figure 5-2.

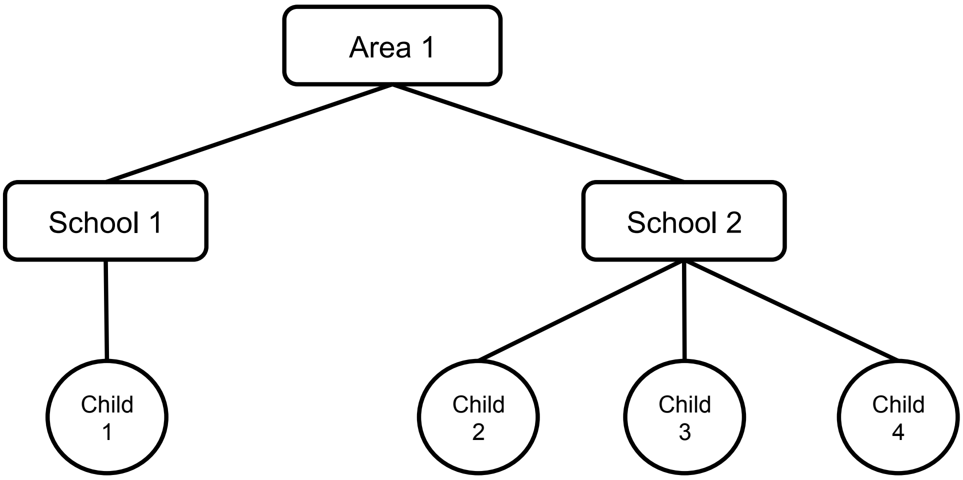
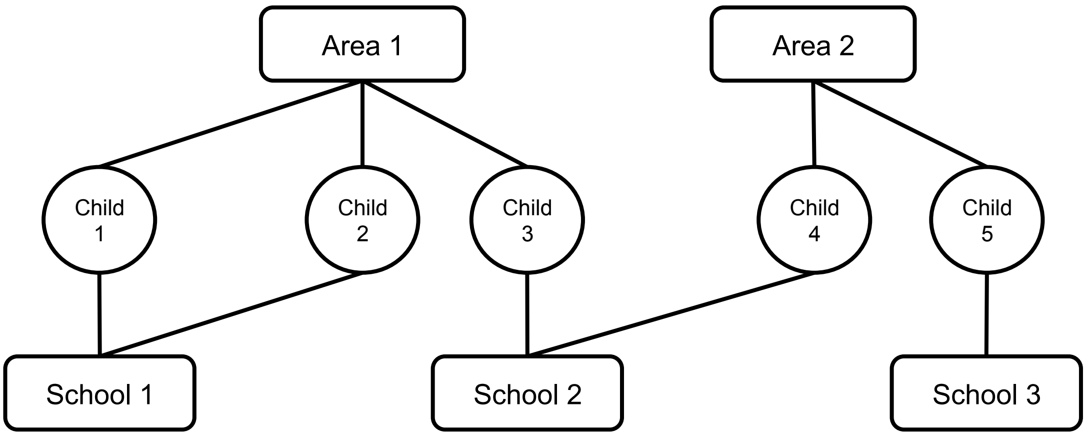


Figure 5-2 Three-level nested data structure

However, in the MCS schools are not completely nested within neighbourhoods. Schools and areas are cross-classified, that means, for 30% of all LSOAs there is more than one school, but also for 40% of schools children come from more than one LSOA. Figure 5-3 illustrates such a cross-classified data structure. In cases like this it is possible to simultaneously estimate the variability at the individual, school and neighbourhood level using cross-classified multilevel models (Fielding and Goldstein, 2006; Rabe-Hesketh and Skrondal, 2008).



Child 2 and child 3 live in the same area but go to different schools, while child 3 and child 4 belong to the same school but live in different areas.

Figure 5-3 Cross-classified data structure (modified from Fielding and Goldstein, 2006)

Notation for a three-level cross-classified model

The two-level model can be extended to include an additional level k (the school), so that it becomes

$y_{i(j,k)} = (X\beta)_{i(j,k)} + u_j + u_k + e_{i(j,k)}$

where

$y_{i(j,k)}$ = the outcome for the individual i in the neighbourhood j and the school k

u_k = added residual term for the school level

$(X\beta)_{i(j,k)}$ = the regression function (Steele and Goldstein, 2007).

Variance Partition Coefficient in a three-level cross-classified model

For a three-level cross-classified model, the VPC can be calculated for each higher level separately, by dividing the between-group variance for the level of interest (e.g. schools) by the total variance, which is then made up by the sum of the variances at each level (schools, neighbourhoods and individuals)[1].

5.2.6 Markov Chain Monte Carlo estimation method

The estimation of cross-classified multilevel models is computationally demanding especially when there are large numbers of groups as it is here the case. The use of maximum likelihood methods to estimate cross-classified models (which is how these models are handled by the Stata package) is deemed inappropriate (Leckie, 2009). Cross-classified models can however be fitted via Markov Chain Monte Carlo (MCMC) estimation methods using the MLwiN package, which has been developed for fitting complex multilevel models (Rasbash et al., 2009). The theory behind MCMC estimation is complex, and a detailed discussion is beyond the scope of this chapter. The approach is based on a Bayesian framework where some prior knowledge (prior distribution) is combined with the collected data, resulting in a new (posterior) distribution (Browne, 2012). The procedure is simulation-based, that means, many iterations are run and at each iteration estimates for

[1] Note that for a simple two-level model, the VPC is equal to the Intraclass Correlation Coefficient (ICC). The ICC represents the correlation between two individuals belonging to the same higher level unit. In a three-level cross-classified model, the calculation of the ICC depends on the combination of higher level units individuals belong to. For example, the school level VPC would be the same as the ICC for 2 individuals who belong to the same school but to different neighbourhoods. For individuals who belong to different schools as well as different neighbourhoods, the ICC would be zero (Leckie, 2013).

the unknown parameters are computed. At each step, new estimates are produced using only the information generated by the last iteration. In other words, the prediction of the next (future) state depends only on the current state but not on the sequence of iterations preceding it. This "memorylessness" is called the Markov property. The goal is for the chain to converge to equilibrium (posterior distribution). From this distribution a sample of values is generated, from which then means, standard deviations and credibility intervals are calculated (corresponding to coefficients, standard errors and confidence intervals of frequentist approaches).

Because the estimates obtained from a Markov chain will slightly differ depending on the choice of starting values and length of the iteration process, there is a degree of uncertainty in the models, which can be seen as a reflection of the uncertainty that is a quality of real life. However, for sufficiently long chains of iterations, the estimates for the fixed effects will be nearly identical to estimates obtained from maximum likelihood methods.

Starting values

In practice, starting values need to be specified. These were estimated from two-level models using a maximum likelihood method (Stata's -xtmixed- command).

Chain length

The chain length refers to the number of iterations run. A higher chain length will result in more precise estimates. The chain length can be increased to ensure the results are stable and different starting values (specified within reason) return similar estimates. Here, a chain length of 50,000 iterations was found to produce stable estimates.

Burn-in period

The burn-in period is a specified number of iterations at the start of the chain that is discarded and not used to generate estimates. The reasoning behind this is that the estimates from initial iterations are more dependent on the starting values than later ones, and might not be representative of the equilibrium distribution. Here, a burn-in period of 1,500 was used.

Bayesian Deviance Information Criterion

The Bayesian Deviance Information Criterion or DIC is a measure of model fit for comparing non-nested models (Spiegelhalter et al., 2002). Smaller DIC values indicate better model fit, with differences of between 5 and 10 or more considered substantial, i.e. statistically significant (Leckie, 2009). The DIC penalises model complexity, so that more parsimonious models are preferred.

The MCMC models return p-values only for the fixed but not for the random effects. The statistical significance of the random effects can be determined by estimating the same model without the random effect in question and comparing the DIC statistic (Dr. G. Leckie, personal communication, 13th August 2012).

5.2.7 Model specifications

To test whether there is significant variation in the outcome variables at the area level, the relationship between exposure and outcome variables was examined mainly using random intercept models. Random intercept models were chosen because the strength of the association between individual characteristics and outcomes was not expected to vary between areas. However, it was also tested whether associations with neighbourhood characteristics were dependent on child-and family-level factors, using random coefficients models as described in section 5.2.8.

Analyses were run with neighbourhoods defined at the LSOA level. Two-level random intercept models were run in Stata version 12.1 using the -xtmixed- command for continuous and the -xtmelogit- command for binary outcomes. Cross-classified models were estimated in MLwiN version 2.26 (Rasbash et al., 2009), via the user-written command -runmlwin- which enables running MLwiN from within Stata (Leckie and Charlton, 2011).

Models were first run as empty models without any explanatory variables, to obtain estimates of the overall between-neighbourhood and between-school variance. Models then sequentially adjusted for child and family characteristics, neighbourhood and school characteristics, and potentially mediating factors. Individual level control variables were selected a priori, informed by the review of the literature. For each model, the between-group variance, within-group variance, percentage of the total variance explained at each level and the VPC are reported. In multilevel modelling, the variances that are estimated are always the variances that are *unexplained* by the model.

The specific modelling strategies and variables included in the analyses are presented for each research aim at the beginning of the relevant results chapter.

Issues of weighting in multilevel models

The use of complex survey weights is not supported by the -xtmixed- and -runmlwin- commands for estimating multilevel models. To get around this problem, advice was followed to include the MCS design strata into the models as explanatory variables (Professor R. Wiggins, personal communication, 22nd August 2012). This approach to the multilevel analysis of MCS data has also been taken elsewhere (Flouri et al., 2009). Because the MCS design strata already contain information on area deprivation[1], their coefficients are shown for all analyses.

However, as stated above, all descriptive analyses used the Stata survey command and MCS survey weights.

5.2.8 Cross-level interactions and complex variation

It is possible that the relationship between a neighbourhood-level characteristic and the outcome varies by some individual-level characteristic, for example the gender of the child. This can be tested by including a cross-level interaction term in the fixed part of the model. In addition, the variance components can be estimated for each category of the individual-level variable separately. For example, including a random coefficient for child gender allows to estimate the between-neighbourhood variance for boys and girls separately. If the between-neighbourhood variability in the outcome differs by gender, this would indicate that neighbourhood factors affect one gender more than the other. It is also possible that the level-one variance (the within-neighbourhood variance) depends on some explanatory variable. For example, there might also be more variation in the outcome at the individual level for one gender compared to the other. This is known as complex level-1 variation or heteroskedasticity (unequal variance) of level-1 residuals. Differences in the between-neighbourhood variability can be called complex level-2 variation (Steele, 2008).

In chapters seven and eight, cross-level interactions and complex variation were tested for child gender and family relative poverty status, to examine whether neighbourhood factors affected children differently depending on their gender or whether they were poor or not poor. This was however done only on two-level models using Stata's -xtmixed- command,

[1] It should however be borne in mind that the design strata correspond to addresses at the point of sampling, which in many cases are different from addresses at later sweeps due to families moving.

as the inclusion of additional random effects in the cross-classified models resulted in too much model complexity and led to problems with convergence.

5.2.9 Testing mediation

A mediator variable is commonly defined as a variable that accounts at least partly for the relationship between an exposure and an outcome variable in the form of a causal chain (Baron and Kenny, 1986). Baron and Kenny (1986) proposed the following three conditions:

1. Changes in the exposure variable are significantly associated with changes in the mediator variable (path a in Figure 5-4).
2. Changes in the mediator variable are significantly associated with changes in the outcome variable (path b).
3. When path a and path b are controlled, a previously significant association between exposure and outcome (path c) is no longer statistically significant or greatly reduced.

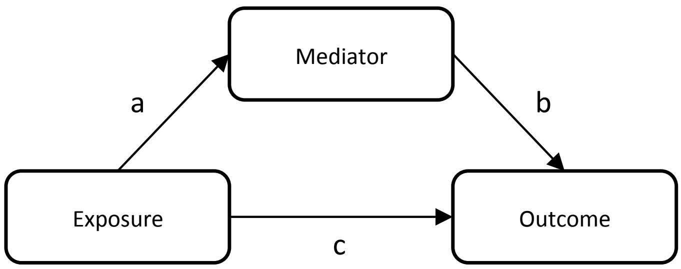


Figure 5-4 Mediation (adapted from Baron and Kenny, 1986)

More recently, this approach has been criticised especially when applied to observational data. It has been argued that formal testing of mediation is anything but trivial, especially when it comes to making causal inferences which is only possible with data from experimental research (Green, Ha and Bullock, 2010).

Here, the investigation was restricted to testing whether the results of the multilevel regression analyses were compatible with the hypothesised indirect pathways, without inferring causality. In the multilevel context, if maternal psychological distress and/or parenting practices were indeed on the pathway between neighbourhood characteristics and child outcomes, adding these measures to the fully adjusted models should result in at least one of the following:

a) A marked reduction in the fixed effects for the neighbourhood characteristics that are included in the model, which should have been previously statistically significant (consistent with mediation),

b) A reduction in the unexplained neighbourhood level variance. This should happen if maternal levels of distress are associated with unknown neighbourhood factors that are not included in the model.

5.2.10 Considerations regarding multilevel models with sparse data

It is common for the multilevel structure of large surveys that there are large numbers of groups (e.g. neighbourhoods or schools), while the average number of observations within these groups is small. This is true also for the MCS, especially at the later sweeps due to families moving. For example, the sweep four cross-sectional analysis sample that was used in chapter seven to examine neighbourhood effects on children's socio-emotional outcomes (N= 9,840) included 4,374 neighbourhoods and 3,882 schools. The average number of observations per neighbourhood was 2.2, and 61% of them were "singletons", i.e. contained only one observation (the average number of observations per school was 2.5, with 57% singletons). Generally, sparseness is not much of a problem for the fixed effects estimates, but can lead to biased estimates of the random effects if there are not enough groups. The literature on multilevel models with sparse data agrees that it is the number of groups that matters most for the estimation of between-group variance, with the number of observations per group becoming less important the larger the number of groups at the higher level (Maas and Hox, 2005; Gelmann and Hill, 2007; Bell, Ferron and Kromrey, 2008; Clarke, 2008). This is because small groups are given less weight in the estimation of group level residuals due to shrinkage. Clarke (2008) showed that unbiased estimates of fixed effects can be obtained with multilevel models even with extremely sparse data (group size <2), and that random effects can also be reliably modelled with sparse data when there is a large number of groups, which is here the case. Bell et al. (2008) demonstrated in a simulation study that a percentage of singletons of up to 70% did not lead to biased estimates as long as the number of groups was large (>500). Therefore, the sparseness of the data was not a concern.

Chapter 6

Results – Maternal psychological distress and parenting

6 Results – Maternal psychological distress and parenting

6.1 Chapter overview

This chapter addresses the first research aim, which was to investigate whether the neighbourhood context influences levels of maternal psychological distress and parenting practices. There should be evidence of such associations if maternal psychological distress and parenting are on the pathway between neighbourhood characteristics and the child outcomes as hypothesised.

The chapter is divided into two parts. The first part seeks to explore whether levels of maternal psychological distress do vary between neighbourhoods (first research objective), and whether mothers' perceptions of their neighbourhood contribute to this variability (second research objective). The second part explores the variability in selected parenting practices across neighbourhoods, and whether this variability was partly explained by differing levels of maternal psychological distress (third research objective). The neighbourhood environment might influence parenting also directly via social processes such as shared norms and beliefs.

Neighbourhoods were characterised by deprivation indices, maternal neighbourhood satisfaction at the individual level as well as aggregated over neighbourhoods, and the interviewer observations of neighbourhood disorder.

To achieve the first and second objectives, data were analysed cross-sectionally and longitudinally. The cross-sectional analyses used data from sweep two of the MCS because both maternal neighbourhood perceptions and interviewer observations have been collected at that sweep. The longitudinal analyses used data from sweeps two and four. Multilevel models were estimated to quantify the variability in the outcome between neighbourhoods (LSOAs and their equivalents in Scotland and Northern Ireland), and to test whether neighbourhood factors contributed independently to levels of maternal distress after adjusting for individual level covariates. The longitudinal analyses used a subsample of residentially stable mothers to test whether neighbourhood satisfaction measured at sweep two was associated with maternal psychological distress at sweep four, around four years later.

The parenting outcomes analysed in the second part of the chapter were "Daily reading"; "Regular bedtimes" and two indicators of harsh parenting, namely "Smacking" and "Daily shouting". Multilevel binary response models were estimated to quantify the variability of the parenting outcomes at the neighbourhood level, and to see whether maternal distress mediated the relationship between neighbourhood characteristics and these aspects of parenting.

6.2 Bivariate analyses

For the bivariate analyses all measures stem from sweep two, when the children were three years old. The analyses were carried out on the maximum number of observations available, using the MCS survey weights.

6.2.1 Social gradients in maternal psychological distress

Maternal psychological distress was measured at sweep two via the Kessler-6 scale[1], where higher scores equal higher levels of distress. For descriptive purposes the Kessler-6 scale was converted into a categorical variable with cut-off points as suggested by Calderwood et al. (2007). These were 0-3 for no distress, 4-12 for moderate distress and 13 or over for severe distress.

Table 6-1 presents the relationships between family background characteristics and levels of maternal psychological distress. The experience of psychological distress was socially patterned: Mothers experiencing distress were on average poorer, had fewer qualifications, were more likely to live in a household where no parent was in work and more likely to be single parents. Compared to mothers who lived in owned or mortgaged accommodation, living in social housing as well as renting privately was also associated with higher levels of distress. The relationship with age appeared to be curvilinear, younger mothers as well as mothers older than 40 were on average more distressed compared to mothers in the 30-39 age group.

[1] A detailed description of the Kessler-6 scale has been given in chapter four (section 4.4.1).

In terms of ethnicity, Pakistani and Bangladeshi mothers appeared to report higher levels of distress compared to White mothers. However, this might be an artefact of the data that is due to item non-response or refusal to answer the self completion part of the study. At sweep two, the items that make up the Kessler-6 score had a poor response rate, and particularly so from ethnic minority mothers. At sweep four, when response rates to these questions were higher, Pakistani mothers were reporting only slightly higher levels of distress.

Table 6-1 Percentages of mothers reporting moderate/severe distress, by maternal and family background characteristics (sweep two, child aged 3 years, max N = 13,414)

	n	Maternal psychological distress (%)	
		Moderate	**Severe**
Family income (N = 11,638)			
Top quintile	2,374	22.3	1.0
Second	2,163	25.7	1.6
Third	2,718	30.8	2.1
Fourth	2,144	36.5	5.5
Bottom quintile	2,239	37.6	7.2
Housing tenure (N = 13,413)			
Owned/mortgaged	8,789	26.6	1.6
Social housing / housing association	3,165	38.1	7.3
Rent privately	954	38.3	5.5
Other (incl. living with parents)	505	30.0	2.8
Maternal highest NVQ (N = 13,396)			
Level 4/5	4,396	26.7	1.3
Level 3	2,049	29.7	3.0
Level 2	4,040	30.4	3.6
Level 1	1,168	33.1	4.8
Overseas only	260	39.9	5.8
None	1,483	38.1	7.1

	n	Maternal psychological distress (%)	
		Moderate	Severe
NS-SEC (mother or partner, whichever was highest, N = 13,414)			
Managerial/Professional	5,146	25.7	1.5
Intermediate	1,475	28.3	2.0
Small empl. / self empl.	1,013	27.4	2.7
Lower supervisory / tech.	1,007	32.4	4.0
Semi routine / routine	2,200	33.9	4.3
No partner in work[1]	2,573	38.7	6.9
Maternal age (N = 13,410)			
40 plus	1,198	31.7	2.5
30-39	7,740	27.5	2.4
20-29	4,351	34.9	5.1
16-19	121	30.4	6.3
Family structure (N = 13,414)			
Both natural parents	10,782	28.0	2.4
Natural mother / other partner	397	40.5	7.0
Single mother	2,235	39.1	6.6
Ethnicity (N = 13,384)			
White	11,712	29.3	3.0
Mixed	101	35.4	5.1
Indian	235	36.5	3.2
Pakistani	337	47.6	7.6
Bangladeshi	88	34.3	10.7
Black Caribbean	155	36.8	3.2
Black African	137	26.7	5.6
Other (incl. Chinese)	619	37.2	4.7

[1] Includes no occupation reported.

6.2.2 Neighbourhood characteristics and maternal psychological distress

The neighbourhood measures used in the following analyses were the Index of Multiple Deprivation (IMD), maternal neighbourhood satisfaction [1] and systematic interviewer observations of what might be described as "neighbourhood disorder"[2].

Figure 6-1 shows the distribution of maternal psychological distress by quintiles of neighbourhood satisfaction. There was a clear gradient in that both moderate and severe maternal distress were negatively correlated with the degree of neighbourhood satisfaction. Among mothers who were least satisfied with their neighbourhood, 40.6% reported moderate symptoms of distress, while 6.2% reported signs of severe distress. In comparison, among mothers most satisfied with the area they lived in, moderate distress was reported by 22.5% and severe distress by only 1.4%. The associations were slightly less steep when the quintiles were based on deprivation indices or interviewer observations (Table 6-2).

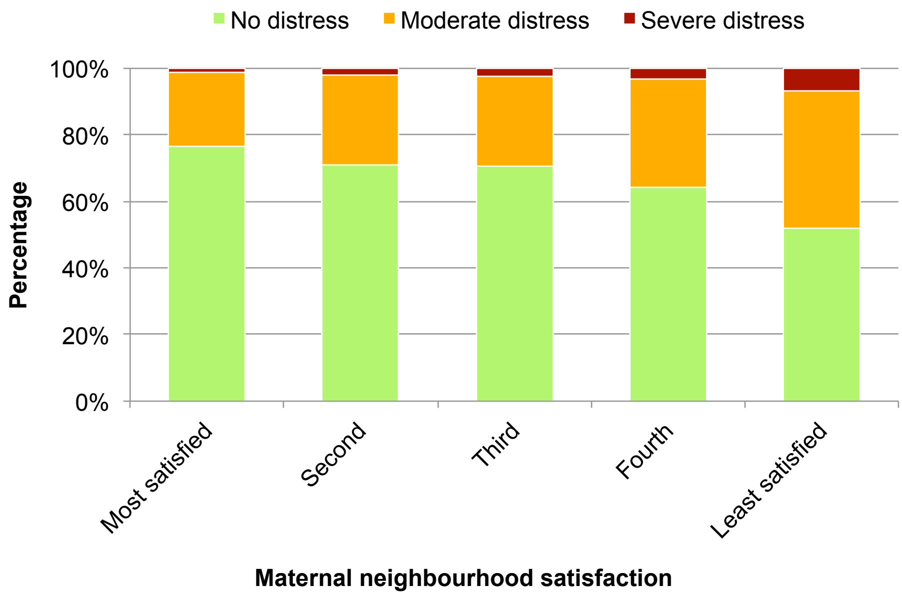


Figure 6-1 Percentage of mothers with no / moderate / severe levels of psychological distress, by neighbourhood satisfaction quintile (N = 13,377)

[1] A detailed description of this measure has been given in chapter four (section 4.3.2). Mothers' ratings included overall satisfaction with the area, whether the area was good to bring up children and feelings of safety. Items were combined via Principal Components Analysis to form a score, which was divided into quintiles.

[2] Interviewers rated aspects of the neighbourhood such as litter and graffiti, run-down buildings as well as how safe and comfortable they felt in the street. Highly correlated items were combined via Principal Components Analysis.

Table 6-2 Percentages of mothers reporting no/moderate/severe distress at sweep two, by neighbourhood characteristics (max. N = 13,413)

Neighbourhood characteristics (quintiles)	n	Level of maternal psychological distress		
		None	Moderate	Severe
Maternal neighbourhood satisfaction				
Most satisfied	2,663	76.1	22.5	1.4
Second	2,616	71.7	26.3	2.0
Third	2,647	70.0	27.4	2.6
Fourth	2,709	63.5	33.3	3.2
Least satisfied	2,742	53.2	40.6	6.2
Neighbourhood IMD				
Least deprived	2,502	73.9	24.8	1.3
Second	2,125	72.2	26.3	1.6
Third	2,486	66.6	30.4	2.9
Fourth	2,917	64.8	31.3	3.9
Most deprived	3,383	56.7	37.2	6.0
Interviewer observations				
Most favourable	2,448	75.5	23.2	1.3
Second	2,398	73.3	25.4	1.3
Third	2,465	66.2	30.9	2.9
Fourth	2,548	62.2	33.6	4.2
Least favourable	3,172	58.5	35.9	5.6

Characteristics associated with low neighbourhood satisfaction

The relationships between neighbourhood disadvantage and maternal levels of distress are likely to be due in part to compositional effects, as individual-level socio-economic factors are expected to affect both maternal mental health as well as residential choices.

The family background characteristics of mothers who reported low neighbourhood satisfaction are shown in Table 6-3. Low neighbourhood satisfaction was strongly associated with socio-economic disadvantage. A high proportion of mothers who reported low neighbourhood satisfaction were poor: of all mothers in the “least satisfied” quintile, 46.2% were living on a family income below 60% of the median of the population.

Social housing was also highly correlated with low neighbourhood satisfaction. Among mothers who were least satisfied with their neighbourhood, 47.7% were living in social housing. To compare, the sample average was 21.2%.

Mothers in the "least satisfied" quintile also tended to be younger, were more likely to have no qualifications, to be out of work and to be a single parent. Also, a higher proportion of them identified as belonging to an ethnic minority.

The bivariate analyses suggest the presence of compositional effects – the same factors associated with maternal distress were also correlated with low neighbourhood satisfaction. These factors will therefore be considered as potential confounders and adjusted for in the multilevel models.

Table 6-3 Family background characteristics (%) at sweep two, by neighbourhood satisfaction quintile (max. N = 14,961)

	n	Most satisfied	Second	Third	Fourth	Least satisfied
Below 60% median income	3,978	15.0	17.2	23.3	27.4	46.2
Housing tenure						
Owned/mortgaged	9,559	82.7	77.3	71.2	66.3	41.2
Social housing	3,714	7.4	12.3	18.3	23.6	47.7
Rent privately	1,090	6.6	6.5	6.6	6.7	7.7
Other	598	3.3	3.8	3.9	3.4	3.3
Mother no qualifications	2,177	6.5	10.4	12.7	13.5	22.2
Mother not in work	7,282	38.6	41.7	41.7	45.7	61.1
Mother ethnic minority group	2,027	6.2	8.3	10.2	10.4	12.6
Single parent	2,535	9.3	9.8	14.6	15.8	26.4
Maternal age						
16 – 19	127	0.2	0.3	0.5	0.8	1.7
20 – 29	4,970	19.7	22.3	27.4	31.8	45.3
30 – 39	8,522	67.9	67.1	63.3	58.6	45.4
40 plus	1,333	12.2	10.3	8.8	8.7	7.6

6.2.3 Social gradients in parenting practices

It has been shown elsewhere that parenting practices vary by family socio-economic and demographic background (Kelly et al., 2011b). Table 6-4 shows the results of bivariate analyses for the selected parenting variables.

The outcomes “Daily reading” and “Regular bedtime” followed a marked social gradient and also appeared to be ethnically patterned. Both variables were strongly and positively associated with maternal education and family income. They also varied by maternal ethnicity, with the lowest percentage of mothers reading daily to their children found among Black African and Bangladeshi mothers. The number of children in the household was negatively and linearly associated with daily reading, and also, although not linearly, with regular bedtimes.

For “Smacking”, the picture looked very different: there was little variation by family income and maternal education, with the exception of the most highly educated mothers who were least likely to report using smacking as a parenting strategy. In general, smacking was common: between 60% and 70% of mothers reported to use it. Smacking was quite evenly distributed among the different ethnic groups, however the lowest percentage of mothers who use smacking was found among Bangladeshi mothers, while among Black Caribbean mothers the practice appeared to be most common.

“Daily shouting” was graded especially by maternal education and also by maternal age, with mothers who were older and more educated being the least likely to report shouting on a daily basis. A higher number of children in the household also appeared to make daily shouting more likely. The association with income was not entirely linear.

Working mothers were more likely to read daily to their child and also more likely to ensure regular bedtimes compared to non-working mothers. While there was no difference in terms of smacking, a higher percentage of non-working mothers reported to shout daily. In terms of the child’s gender, a higher percentage of boys were exposed to smacking as well as to daily shouting.

From the bivariate analyses there appeared to be social gradients for daily reading and regular bedtimes, and to a lesser extent for daily shouting. The use of smacking was however common across social strata.

Table 6-4 Parenting practices at age three, by family characteristics (max. N = 14,999)

	n	Daily reading	Regular bedtime	Smacking used	Shouting daily
Family income					
Top quintile	2,466	75.3	89.8	61.2	10.6
Second	2,256	70.3	85.5	66.4	14.0
Third	2,874	61.7	82.2	71.0	20.6
Fourth	2,434	51.4	74.0	68.7	20.9
Bottom quintile	2,649	47.1	71.5	68.3	22.9
Maternal highest NVQ					
Level 4/5	4,638	75.4	89.0	61.2	12.6
Level 3	2,154	64.7	83.8	68.5	19.6
Level 2	4,312	55.6	77.4	72.5	18.8
Level 1	1,269	45.8	71.1	70.4	24.0
Overseas only	422	46.4	64.2	68.2	19.4
None	2,182	33.8	64.0	62.9	24.5
Work status					
Mother in work	7,690	65.6	83.9	66.4	15.0
Mother not in work	7,309	56.5	76.8	67.1	20.2
Maternal age					
40 plus	1,339	65.5	78.1	59.6	10.3
30 – 39	8,542	65.3	83.1	66.2	15.4
20 – 29	4,983	52.4	76.5	70.4	23.4
16 – 19	126	51.9	66.5	61.4	29.0
Family structure					
Both natural parents	12,040	62.1	80.1	67.1	16.7
Natural mother / other partner	414	44.4	73.7	65.5	24.3
Single mother	2,545	48.9	73.6	66.2	22.5
Ethnicity					
White	12,287	64.1	82.4	66.9	17.1
Mixed	126	50.8	70.4	71.5	25.5
Indian	364	46.4	73.3	67.9	20.0
Pakistani	645	36.6	67.2	57.8	20.1
Bangladeshi	247	26.3	68.2	45.2	18.5
Black Caribbean	175	43.5	63.6	78.4	18.2
Black African	235	29.3	58.9	72.7	13.1
Other (incl. Chinese)	884	48.4	66.3	67.6	17.9

	n	Daily reading	Regular bedtime	Smacking used	Shouting daily
Child's gender					
Boy	7,671	59.9	80.9	69.7	19.3
Girl	7,328	63.1	80.3	63.6	15.1
Number of children in household					
One	3,719	69.3	78.7	64.3	14.3
Two	6,752	65.0	84.7	68.3	18.6
Three	2,903	52.0	78.8	67.8	17.5
Four	1,108	44.7	70.1	63.1	17.4
Five or more	517	30.2	61.0	59.8	20.0

6.2.4 Parenting practices and maternal psychological distress

Table 6-5 shows the relationships between the selected parenting practices at age three and maternal psychological distress. There were clear associations: children of mothers who experienced mild or severe symptoms of depression were less likely to be read to daily and to have a regular bedtime, but more likely to be exposed to harsh parenting methods.

While 66% of mothers with no symptoms of distress reported reading to their child every day, this was true for 45% of mothers who experienced severe levels of distress. Similarly, 46% of non-distressed mothers reported that their children had regular bedtimes, compared to 33% of the severely distressed. Mothers who experienced distress were more likely to use smacking and shouting as ways to discipline their children. Of the mothers with no symptoms of distress, 7% reported to smack their child once a week or more, while among mothers with severe symptoms of distress this was reported by 13%. Daily shouting was reported by 14% of non-distressed mothers but by 35% of the severely distressed.

Table 6-5 Parenting practices at age three, by level of maternal psychological distress (max. N= 13,405)

	n	Level of maternal distress (%)		
		None	**Moderate**	**Severe**
How often mother reads to the child (N = 12,293)				
Every day	7,991	66.0	57.9	44.8
Several times a week	2,605	18.1	20.7	21.2
Once or twice a week	2,005	11.9	14.8	20.4
Once or twice a month	349	1.9	3.1	4.6
Less often	237	1.1	2.0	2.2
Not at all	218	0.9	1.6	6.8
Regular bedtime (N = 12,293)				
Never / almost never	1,003	5.4	8.5	13.7
Sometimes	1,736	10.8	13.3	17.4
Usually	5,130	28.2	40.8	35.6
Always	5,536	45.5	37.3	33.3
Smacking (N = 12,142)				
Never	4,428	34.6	30.7	27.4
Rarely	6,883	52.5	52.2	50.3
Once a month	636	5.1	5.3	5.4
Once a week or more	1,120	7.1	10.7	13.2
Daily	130	0.7	1.1	3.7
Shouting (N = 12,107)				
Never	434	3.3	2.1	3.5
Rarely	4,302	35.0	24.7	21.2
Once a month	976	8.7	7.3	5.5
Once a week or more	5,026	39.3	42.3	35.0
Daily	2,397	13.7	23.6	34.9

6.2.5 Neighbourhood characteristics and parenting practices

This section is looking at how parenting practices varied by the level of area deprivation and mothers' neighbourhood perceptions. The associations are presented as figures for clarity and ease of interpretation. The markers of parenting were dichotomised in the same way as in the later multilevel analyses. A score of 1 was given for "Daily reading" if the mother responded to the question: "How often do you read to (child)?" with "Every day". Children were coded (score=1) as having "Regular bedtimes" when the mother had answered the question "Does (child) go to bed at regular times?" with "Always" or "Usually". For the variable "Smacking", a score of 1 was given if the mother reported to use smacking as a discipline strategy at all, and a score of 0 if she reported to never smack her child. "Shouting daily" was coded as 1 if the mother reported to shout every day. Tables with the corresponding numbers including p-values of tests for trend are provided in Appendix III.

"Daily reading" and "Regular bedtimes"

Parenting activities and routines such as daily reading and regular bedtimes were significantly associated with the degree of neighbourhood disadvantage (Figure 6-2). The association with "Daily reading" was particularly strong, ranging from 43.4% in the most deprived neighbourhoods to 75.5% in the least deprived. The associations with maternal neighbourhood satisfaction were similarly patterned but less steep (Figure 6-2).

Use of harsh parenting practices

In contrast, the use of harsh parenting practices such as smacking and shouting was less spatially patterned (Figure 6-3) For smacking, there was no clear association with the level of neighbourhood deprivation (p-value test for trend not statistically significant, see Appendix III, Table 11-6). It appeared that higher percentages of mothers from the middle deciles reported to use smacking, while the percentages at both ends of the distribution were slightly lower. For daily shouting, there was a small gradient: mothers from more deprived areas were more likely to shout daily.

It has been hypothesised that the use of harsh parenting practices is more closely related to maternal perceptions of neighbourhood safety and quality than to measures of deprivation derived from census data (Leventhal and Brooks-Gunn, 2000). However, the associations of harsh parenting with maternal neighbourhood satisfaction appeared to follow a similar pattern to those with levels of area deprivation (Figure 6-3).

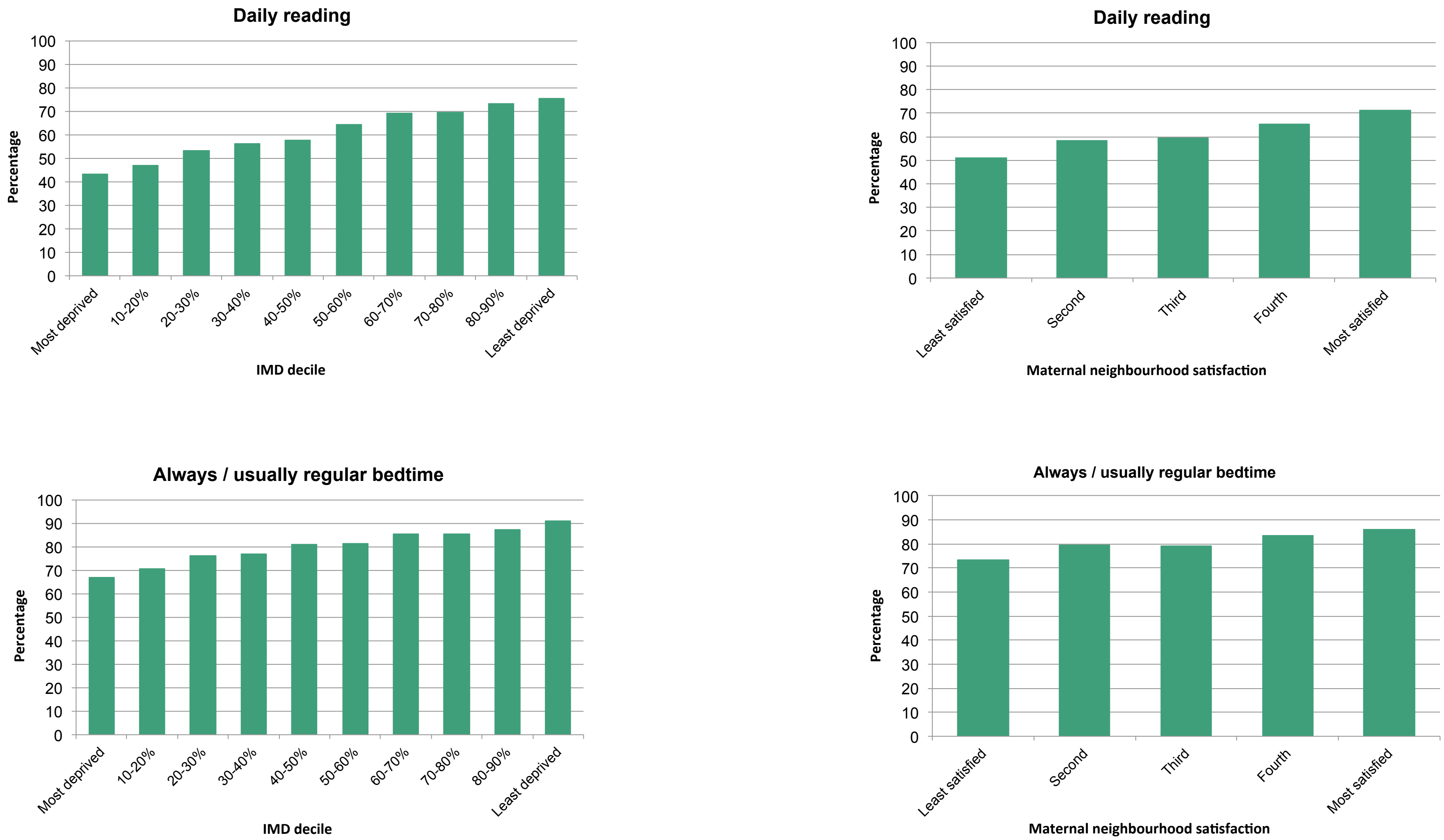


Figure 6-2 “Daily reading” and “Regular bedtimes” at age three, by IMD decile and maternal neighbourhood satisfaction

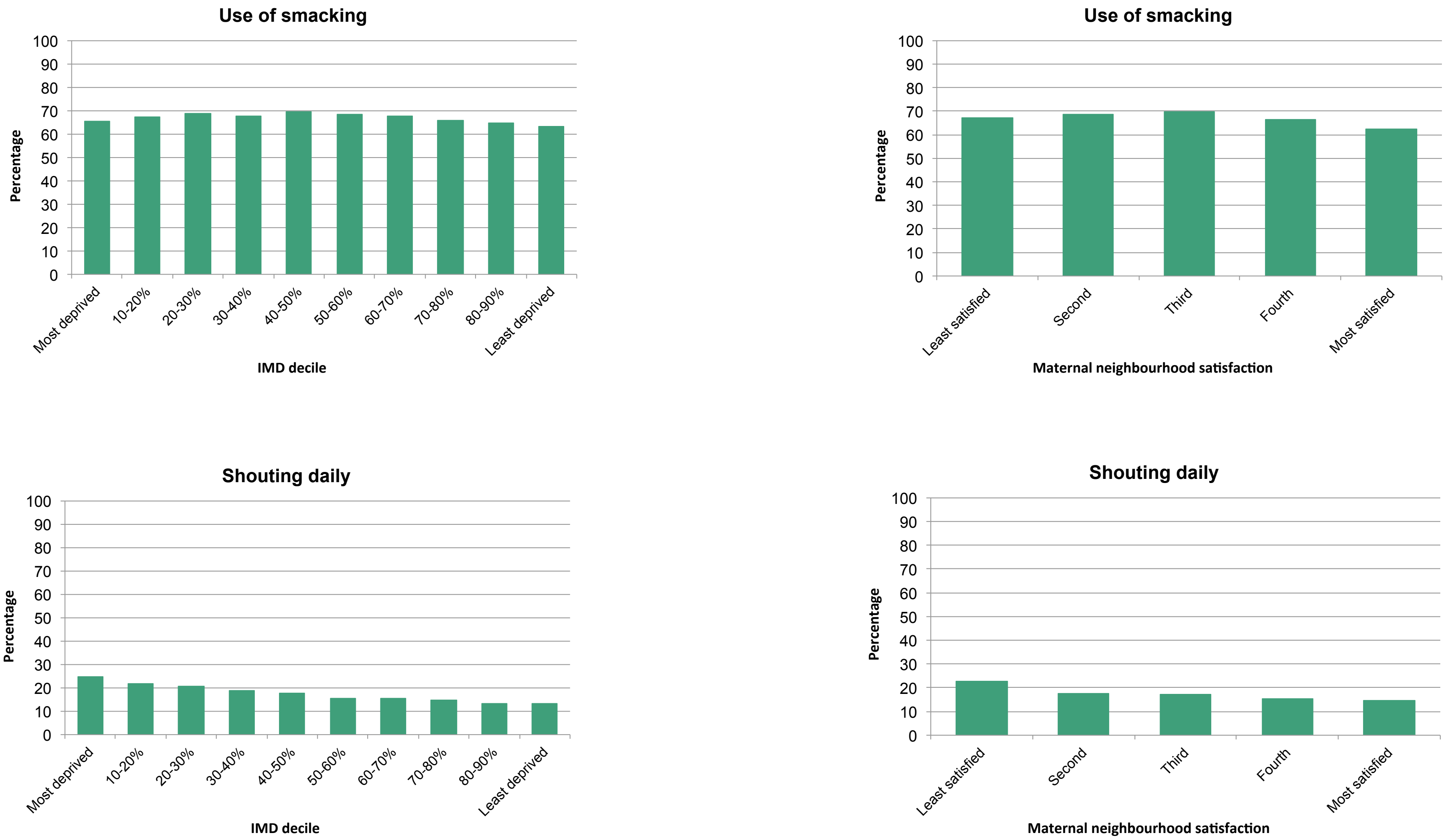


Figure 6-3 Markers of harsh parenting at age three, by IMD decile and maternal neighbourhood satisfaction

6.3 Neighbourhoods and maternal psychological distress

The between-neighbourhood variability in levels of maternal psychological distress and contribution of neighbourhood exposures after adjusting for individual level confounders were estimated using multilevel random intercept models. The outcome – maternal psychological distress – was measured via the Kessler-6 scale as a continuous variable.

The data were analysed cross-sectionally and longitudinally. For all models, the tables display the between-neighbourhood variance, percentage of the total between-neighbourhood variance[1] explained by the model, within-neighbourhood variance and Variance Partition Coefficient (VPC).

6.3.1 Multilevel models – cross-sectional analysis

6.3.1.1 Analytical strategy

Analysis sample and neighbourhood predictors

The cross-sectional analysis used data from sweep two of the study, when the cohort children were three years old. Included in the analysis were only mothers who had lived in the same neighbourhood since sweep one[2] (or, if they had joined the study at sweep two, who had been residentially stable for at least two years). The final sample size for the cross-sectional analysis was 7,766, nested in 1,986 LSOAs. The average number of observations per LSOA in the analysis sample was 3.9, with a minimum of 1 and a maximum of 33.

The relationships between maternal psychological distress and the following neighbourhood exposures were examined: (1) the Index of Multiple Deprivation; (2) maternal neighbourhood satisfaction measured at the individual level; (3) maternal neighbourhood satisfaction scores aggregated to the neighbourhood level, i.e. over LSOAs and their equivalents; and (4) interviewer observations of "neighbourhood disorder". Associations with the latter two measures were tested to tease out the influence of same-source bias. Because the measures of maternal neighbourhood satisfaction and interviewer observations were correlated and to enable comparisons, associations were examined for each exposure separately.

[1] Total between-neighbourhood variance = neighbourhood variance estimated by the empty model.

[2] This includes mothers who moved within the same neighbourhood.

Covariates

All models except the empty model adjusted for the MCS design strata, the survey design variable that holds information on the UK country as well as the characteristics of the electoral ward the family had been initially recruited from (advantaged, disadvantaged or ethnically diverse). As has been discussed in chapter five, including this variable in the analysis is recommended where the use of MCS sampling weights is not feasible, as was here the case[1].

The following individual level covariates were included: maternal age; maternal ethnicity, family structure, maternal education (NVQ level); weekly family income (scaled so that 1 unit corresponded to £100 per week); NS-SEC of either the mother or her partner, whichever was higher; and housing tenure. Because the bivariate analyses suggested that the relationship between maternal age and psychological distress might be curvilinear, it was also tested whether a quadratic term for maternal age had any explanatory power. However, the quadratic term was not statistically significant and was not included in the final model specification.

Multilevel models

The following sequence of models was run:

Model A was the variance components model or empty model, estimating the variance between neighbourhoods before any explanatory variables were taken into account.

Model B adjusted for MCS strata and individual level covariates only.

Model C adjusted for MCS strata, individual level covariates and the Index of Multiple Deprivation (in deciles). This model was estimated as a separate step to test whether potential associations with neighbourhood deprivation were mediated by mothers' neighbourhood perceptions.

Model D adjusted for MCS strata, individual level covariates, the Index of Multiple Deprivation deciles and maternal neighbourhood satisfaction at sweep two[2].

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[1] A detailed description of the MCS strata has been given in chapter four. For a more detailed discussion regarding the issue of weighting see chapter five (section 5.2.7).

[2] A detailed description of the measure has been given in chapter four (section 4.3.2). Mothers' ratings included overall satisfaction with the area, whether the area was good to bring up children and feelings of safety. Items were combined via Principal Components Analysis to form a score, which was divided into quintiles.

Model E adjusted for MCS strata, individual level covariates, the Index of Multiple Deprivation deciles and maternal neighbourhood satisfaction at sweep two, this time aggregated over neighbourhoods.

Model F adjusted for MCS strata, individual level covariates, the Index of Multiple Deprivation deciles and systematic interviewer observations of “neighbourhood disorder”[1].

6.3.1.2 Results

Model A in Table 6-6 shows the results for the empty model or variance components model. The average Kessler-6 score in this sample was 3.1 points. The between-neighbourhood or level-2 variance was 0.7, which was statistically significant at the 0.001 level. About 5% of the total variance in maternal levels of distress was due to differences between neighbourhoods (VPC = between-neighbourhood variance / total variance = 0.050).

Adjusting for MCS strata and individual-level covariates (Model B in Table 6-6) reduced the level-2 variance to 0.1 and therefore explained approximately 80% of the original between-neighbourhood variability that was calculated in Model A. With these adjustments, the between-neighbourhood variance was no longer statistically significant. In terms of the family background characteristics, it appeared that a higher family income, having a partner and belonging to a family where at least one partner was in work were protective factors, i.e. were associated with less psychological distress. Mothers who had no or only overseas qualifications scored on average 0.6 and 0.7 points higher, respectively, on the Kessler-6 compared to highly educated mothers (NVQ level 4 or 5). It is of note that living in social housing as well as renting privately was also associated with higher scores (an average increase of about 0.9 points) when compared to mothers living in owned or mortgaged accommodation, a result that was highly statistically significant. There was no independent relationship between psychological distress and maternal age net of the other family background characteristics. Higher coefficients were found for Indian and especially Pakistani mothers, which might be partly due to item non-response as has been discussed earlier (section 6.2.1).

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[1] Interviewers rated aspects of the neighbourhood such as litter and graffiti, run-down buildings as well as how safe and comfortable they felt in the street. Highly correlated items were combined via Principal Components Analysis.

Model C (Table 6-6) introduced the Index of Multiple Deprivation. With the most deprived decile as the reference category, mothers living in the least deprived neighbourhoods scored on average 0.6 points lower on the Kessler-6 scale. The associations with the family level covariates remained almost unchanged. There was also no important change in the neighbourhood variance, which had already been largely explained by the previous model. The IMD as a measure of area deprivation did not contribute independently to the variability in the outcome between neighbourhoods over and above family level factors.

Model D shows a linear and negative relationship between mothers' reports of psychological distress and their satisfaction with the neighbourhood. Mothers who reported the lowest satisfaction with their area scored on average 1.4 points higher on the Kessler-6 scale than mothers who were most satisfied, after allowing for the influence of family background factors. Compared to model C, the association with neighbourhood deprivation (IMD) was attenuated and no longer statistically significant, suggesting a mediating pathway via mothers' neighbourhood perceptions. The coefficient for social housing (but not for renting privately) was also reduced. In this model, the between-neighbourhood variance was again marginally statistically significant, with about 1% of the unexplained variability in the outcome due to differences between neighbourhoods.

Table 6-6 Results of multilevel models predicting maternal psychological distress (Kessler-6 score) at sweep two, cross-sectional analysis (N=7,766)

	Estimate (Standard Error)			
	Model A	**Model B**	**Model C**	**Model D**
MCS stratum (ref = England - advantaged)				
England – disadvantaged		0.12 (0.12)	-0.07 (0.14)	-0.19 (0.14)
England – ethnic		0.07 (0.21)	-0.15 (0.22)	-0.39 (0.23)
Wales – advantaged		-0.14 (0.19)	-0.09 (0.19)	-0.03 (0.19)
Wales – disadvantaged		0.00 (0.15)	-0.15 (0.16)	-0.15 (0.16)
Scotland – advantaged		-0.35 (0.17)*	-0.36 (0.17)*	-0.27 (0.17)
Scotland – disadvantaged		0.17 (0.18)	0.03 (0.19)	-0.05 (0.19)
NI – advantaged		-0.54 (0.21)*	-0.51 (0.21)*	-0.41 (0.21)
NI – disadvantaged		0.29 (0.19)	0.09 (0.21)	0.22 (0.21)
Individual level covariates				
Maternal age (years)		0.00 (0.01)	0.01 (0.01)	0.01 (0.01)
Maternal ethnicity (ref = White)				
Mixed		0.11 (0.50)	0.11 (0.50)	0.11 (0.49)
Indian		1.29 (0.34)***	1.30 (0.34)***	1.24 (0.34)***
Pakistani		2.28 (0.29)***	2.24 (0.29)***	2.38 (0.29)***
Bangladeshi		0.48 (0.59)	0.44 (0.59)	0.54 (0.58)
Black Caribbean		-0.08 (0.38)	-0.09 (0.38)	-0.04 (0.38)
Black African		-0.35 (0.40)	-0.37 (0.40)	-0.21 (0.40)
Other (incl. Chinese)		0.52 (0.23)*	0.53 (0.23)*	0.55 (0.23)*
Family structure (ref = both natural parents				
Natural mother / other partner		0.63 (0.32)*	0.61 (0.32)	0.60 (0.32)
Single mother		0.41 (0.14)**	0.40 (0.14)**	0.40 (0.14)**
Maternal NVQ (ref = level 4/5)				
Level 3		0.01 (0.13)	-0.01 (0.13)	-0.02 (0.12)
Level 2		-0.06 (0.11)	-0.08 (0.11)	-0.10 (0.11)
Level 1		-0.04 (0.17)	-0.06 (0.17)	-0.06 (0.17)
Overseas		0.69 (0.31)*	0.67 (0.31)*	0.66 (0.31)*
None		0.57 (0.16)**	0.54 (0.16)**	0.54 (0.16)**
Weekly family income, per £100		-0.08 (0.02)***	-0.08 (0.02)***	-0.07 (0.02)***

Table 6-6 (continued)

	Estimate (Standard Error)			
	Model A	**Model B**	**Model C**	**Model D**
NS-SEC (ref= manag. / prof.)				
Intermediate		0.08 (0.14)	0.07 (0.14)	0.08 (0.14)
Small empl. / self empl.		-0.35 (0.17)*	-0.36 (0.17)*	-0.33 (0.17)*
Lower supervisory / tech.		0.25 (0.16)	0.22 (0.16)	0.24 (0.16)
Semi routine / routine		-0.07 (0.14)	-0.10 (0.14)	-0.07 (0.14)
No partner in work		0.46 (0.15)**	0.44 (0.15)**	0.46 (0.15)**
Housing tenure (ref= owner)				
Rented privately		0.86 (0.20)***	0.85 (0.20)***	0.85 (0.20)***
Social housing		0.92 (0.13)***	0.87 (0.13)***	0.67 (0.13)***
Other		-0.20 (0.23)	-0.21 (0.23)	-0.20 (0.23)
Neighbourhood exposures				
IMD decile (ref = most deprived)			-0.06 (0.02)*	-0.02 (0.02)
Maternal neighbourhood satisfaction (ref = most satisfied)				
Second quintile				0.43 (0.13)**
Third quintile				0.45 (0.13)**
Fourth quintile				0.80 (0.13)***
Least satisfied				1.40 (0.14)***
Constant	3.12 (0.05)***	2.79 (0.32)***	3.14 (0.34)***	2.20 (0.36)***
Between neighbourhood variance	0.65 (0.12)***	0.13 (0.10)^{NS}	0.12 (0.10)^{NS}	0.16 (0.10)*
% of total between-neighbourhood variance explained[1]	–	80.0	81.5	75.4
Within neighbourhood variance	12.27 (0.22)***	11.88 (0.21)***	11.87 (0.21)***	11.68 (0.21)***
Total variance	12.92	12.01	11.99	11.84
% of unexplained variance due to neighbourhoods (VPC)	5.0	1.1	1.0	1.4

*** p < 0.001 ** p < 0.01 *p < 0.05 ^{NS} Random effect not statistically significant

[1] Total between-neighbourhood variance = neighbourhood variance estimated by the empty model (or variance components model).

Comparison between different neighbourhood exposures

It is possible that distressed mothers are prone towards reporting more negatively on their neighbourhood, so the results of the previous analysis could be due to reverse causality. To test the robustness of the previous findings, additional models were estimated using (1) an aggregated measure of maternal neighbourhood satisfaction (Model E) and (2) interviewer observations of "neighbourhood disorder" (Model F) as exposure variables. All models adjusted for the same covariates as before. The results are presented in Table 6-7. For brevity and easier comparison, only the coefficients of the neighbourhood exposures are shown, however the full table is provided in Appendix IV (Table 11-8).

In all three models, the association with neighbourhood IMD was not statistically significant (data shown in Appendix IV, Table 11-8). Comparison of the three measures showed that mothers' satisfaction with the neighbourhood measured at the individual level was most strongly associated with levels of distress. The relationship was less strong but still linear and statistically significant when maternal neighbourhood satisfaction was aggregated over neighbourhoods. Compared to mothers who lived in areas where average neighbourhood satisfaction was highest, mothers scored on average 0.9 points higher on the Kessler-6 scale in neighbourhoods where satisfaction was lowest (Model E in Table 6-7). The associations with interviewer ratings were the least strong. The average difference in Kessler-6 scores between areas with the most versus the least favourable interviewer ratings was 0.5 points (Model F in Table 6-7).

When all three measures were entered at the same time, the estimates for the aggregated measure of neighbourhood satisfaction as well as for interviewer observations were no longer statistically significant, while the coefficients for individual level neighbourhood satisfaction remained virtually unchanged (data not shown).

In summary, maternal neighbourhood satisfaction was significantly and linearly associated with levels of psychological distress after family socio-economic factors were taken into account, and this was true even when neighbourhood satisfaction was aggregated over neighbourhoods. Interviewer observations of social disorder were also predictive of the outcome, however the association was less strong.

Table 6-7 Results of multilevel models predicting maternal psychological distress (Kessler-6 score) at sweep two, comparison of different neighbourhood exposures, cross-sectional analysis (N=7,766)[1]

	Estimate (Standard Error)		
	Model D[2]	**Model E**[3]	**Model F**[4]
Neighbourhood exposures			
Maternal neighbourhood satisfaction (ref = most satisfied)			
Second quintile	0.43 (0.13)**		
Third quintile	0.45 (0.13)**		
Fourth quintile	0.80 (0.13)***		
Least satisfied	1.40 (0.14)***		
Aggregated neighbourhood satisfaction (ref = most satisfied)			
Second quintile		0.30 (0.14)*	
Third quintile		0.41 (0.15)**	
Fourth quintile		0.48 (0.18)**	
Least satisfied		0.85 (0.20)***	
Interviewer observations (ref = most favourable)			
Second			-0.10 (0.13)
Third			0.24 (0.13)
Fourth			0.35 (0.14)*
Least favourable			0.45 (0.15)***
Constant	2.20 (0.36)***	2.53 (0.38)***	2.73 (0.37)***
Between neighbourhood variance	0.16 (0.10)*	0.11 (0.10)NS	0.13 (0.10)NS
% of total neighbourhood variance explained	75.4	83.1	80.0
Within neighbourhood variance	11.68 (0.21)***	11.86 (0.21)***	11.84 (0.21)***
Total variance	11.84	11.97	11.97
VPC	1.4	0.9	1.1

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ NS Random effect not statistically significant

[1] All models adjusted for MCS stratum, maternal age, maternal ethnicity, family structure, maternal NVQ level, family income, NS-SEC, housing tenure and IMD

[2] Exposure: maternal neighbourhood satisfaction (same model as Model D in Table 6-6)

[3] Exposure: maternal neighbourhood satisfaction aggregated over neighbourhoods

[4] Exposure: interviewer observations of neighbourhood disorder

6.3.2 Multilevel models – longitudinal analysis

6.3.2.1 Analytical strategy

Analysis sample and neighbourhood predictors

Only mothers who were residentially stable between sweeps two and four were included in the longitudinal analysis, resulting in a sample size of 7,387. The number of LSOAs in the analysis sample was 3,158, and the average number of observations per LSOA was 2.3, ranging from 1 to 31. The neighbourhood predictors were mothers' neighbourhood satisfaction and interviewer observed neighbourhood disorder at sweep two. The outcome was maternal psychological distress at sweep four. Between the two time points lay approximately four to five years.

Covariates

The models adjusted for the same socio-demographic covariates that had been included in the cross-sectional analysis. In addition, the final model took the baseline level of maternal psychological distress into account, which was measured at sweep two also via the Kessler-6 scale. Mothers experiencing distress at sweep two might have reported lower neighbourhood satisfaction as a consequence of being distressed, while at the same time mothers reporting distress at one time point are more likely to report distress also at a later time point. Adjusting for the baseline level of distress was therefore considered important to minimise the possibility of same-source bias and reverse causality. However, it might be that baseline distress was already partly influenced by neighbourhood characteristics, in which case the following results would be conservative.

Multilevel models

The following models were estimated:

Model A was again the empty model.

Model B then adjusted for MCS strata and individual level covariates. All covariates were measured at sweep four.

Model C adjusted for MCS strata, individual level covariates, the Index of Multiple Deprivation, and observed neighbourhood disorder. This was done to remove the potential for same-source bias, so that adjusting (and possibly over-controlling) for maternal distress at sweep two could be foregone and estimates could be compared with the following models.

Model D adjusted for MCS strata, individual level covariates, IMD at sweep two[1] and maternal neighbourhood satisfaction at sweep two, measured at the individual level.

Model E additionally adjusted for baseline maternal psychological distress (Kessler-6 score). Therefore, this model predicted whether maternal neighbourhood perceptions at sweep two were associated with a change in the level of maternal distress.

6.3.2.2 Results

The empty model shows that in this sample of residentially stable mothers, 4.1% of the total variance in maternal levels of distress was between neighbourhoods, which is slightly less than in the cross-sectional analysis (Model A, Table 6-8). The between-neighbourhood variance was 0.56, and statistically significant at the 0.001 level.

Table 6-8 Model A - Variability in maternal psychological distress (Kessler-6 score) between neighbourhoods, sweep four, longitudinal analysis (N=7,387)

	Estimate (Standard Error)
Constant	2.94 (0.05)***
Between-neighbourhood variance	0.56 (0.15)***
Within-neighbourhood variance	13.07 (0.25)***
Total variance	13.63
% of total variance due to differences between neighbourhoods (VPC)	**4.1**

*** p < 0.001

The relationships with the individual level covariates were largely consistent with what had been found in the cross-sectional analyses (Model B in Table 6-9). Again, living in social housing was independently associated with higher levels of distress: mothers living in social housing scored on average 0.7 points higher than mothers in owned or mortgaged housing. Other factors strongly associated with higher levels of distress were family income, having no qualifications and living in a household where no partner was in work. Model B

[1] The IMDs at sweep two and sweep four were almost identical (correlation coefficient = 0.999)

explained about 80% of the total neighbourhood variance, which was no longer statistically significant.

Model C in Table 6-9 shows a statistically significant relationship between interviewer-observed neighbourhood disorder at sweep two and maternal psychological distress at sweep four, but the association was weak and not linear. Mothers living in neighbourhoods which had been rated less favourably (3rd to 5th quintile) scored on average 0.4 to 0.5 points higher on the Kessler-6 at sweep four. The IMD was unrelated to the outcome.

Model D in Table 6-9 shows that mothers' reported neighbourhood satisfaction at sweep two was associated in a linear fashion with maternal psychological distress at sweep four, independent of the family-level covariates. Mothers who were least satisfied with their area at sweep two scored on average 1.3 points higher on the Kessler-6 scale at sweep four. In contrast to the findings of the cross-sectional analysis, there was no evidence that maternal neighbourhood perceptions mediated the relationship between IMD and maternal psychological distress. In a separate model with only the IMD as the neighbourhood exposure, the association with IMD was not statistically significant either (data not shown). The coefficient for living in social housing was reduced compared to Model B, suggesting that issues around social housing were among the reasons for low neighbourhood satisfaction.

As expected, the relationship with baseline levels of psychological distress was positive and highly significant: for each point on the Kessler-6 scale at sweep two, the average score at sweep four increased by about 0.5 points (Model E in Table 6-9). Allowing for the influence of baseline distress levels resulted in a sharp reduction in the coefficients for the neighbourhood satisfaction variable, however the association remained statistically significant for the fourth and fifth quintile. Given equal baseline levels of distress, mothers who had been least satisfied with their neighbourhood at sweep two scored on average 0.6 points higher on the Kessler-6 at sweep four, when compared to mothers who had been most satisfied. The relationship with social housing was also greatly attenuated, indicating that mothers living in social housing had higher baseline levels of distress.

It appears that neighbourhood satisfaction measured four to five years earlier was associated with increased maternal psychological distress amongst residentially stable mothers, after allowing for individual-level covariates and baseline level of distress.

Table 6-9 Results of multilevel models predicting maternal psychological distress at sweep four (Kessler-6 score). Exposure: maternal neighbourhood satisfaction at sweep two. Longitudinal analysis, N = 7,387.

	Estimate (Standard Error)			
	Model B	**Model C**	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)				
England – disadvantaged	0.15 (0.12)	0.08 (0.13)	0.02 (0.13)	0.13 (0.11)
England – ethnic	-0.31 (0.22)	-0.41 (0.23)	-0.51 (0.23)*	-0.33 (0.20)
Wales – advantaged	-0.08 (0.20)	-0.08 (0.19)	-0.01 (0.19)	0.03 (0.17)
Wales – disadvantaged	0.09 (0.15)	0.04 (0.16)	0.04 (0.16)	0.05 (0.14)
Scotland – advantaged	-0.24 (0.18)	-0.20 (0.18)	-0.16 (0.18)	-0.12 (0.16)
Scotland – disadvantaged	-0.11 (0.20)	-0.16 (0.20)	-0.21 (0.20)	-0.05 (0.18)
NI – advantaged	-0.57 (0.21)**	-0.49 (0.21)*	-0.46 (0.21)*	-0.23 (0.19)
NI – disadvantaged	-0.52 (0.19)**	-0.54 (0.20)**	-0.43 (0.20)*	-0.42 (0.18)*
Individual level covariates				
Maternal age (years)	0.02 (0.01)**	0.02 (0.01)**	0.02 (0.01)**	0.02 (0.01)**
Maternal ethnicity (ref = White)				
Mixed	0.11 (0.52)	0.11 (0.52)	0.10 (0.52)	0.01 (0.45)
Indian	0.51 (0.34)	0.44 (0.33)	0.50 (0.33)	0.13 (0.29)
Pakistani	0.60 (0.32)	0.58 (0.32)	0.66 (0.32)*	-0.29 (0.28)
Bangladeshi	0.78 (0.63)	0.75 (0.63)	0.90 (0.62)	0.46 (0.54)
Black Caribbean	0.56 (0.40)	0.52 (0.40)	0.56 (0.40)	0.28 (0.35)
Black African	0.32 (0.47)	0.26 (0.47)	0.31 (0.47)	0.23 (0.41)
Other (incl. Chinese)	0.62 (0.45)	0.55 (0.45)	0.59 (0.45)	0.38 (0.39)
Family structure (ref = both natural parents				
Natural mother / other partner	0.58 (0.22)**	0.57 (0.22)*	0.54 (0.22)*	0.06 (0.19)
Single mother	0.43 (0.13)**	0.42 (0.13)**	0.41 (0.13)**	0.29 (0.11)*
Maternal NVQ (ref = level 4/5)				
Level 3	-0.01 (0.13)	-0.01 (0.13)	-0.01 (0.13)	-0.03 (0.11)
Level 2	0.04 (0.11)	0.02 (0.11)	0.02 (0.11)	0.05 (0.10)
Level 1	-0.30 (0.18)	-0.34 (0.18)	-0.32 (0.18)	-0.20 (0.16)
Overseas	0.68 (0.33)*	0.67 (0.33)*	0.67 (0.33)*	0.47 (0.29)
None	0.47 (0.19)*	0.42 (0.19)*	0.45 (0.18)*	0.36 (0.16)*
Weekly family income / £100	-0.14 (0.02)***	-0.12 (0.03)***	-0.13 (0.02)***	-0.09 (0.02)***

Table 6-9 (continued)

	Estimate (Standard Error)			
	Model B	**Model C**	**Model D**	**Model E**
NS-SEC (ref= manag. / prof.)				
Intermediate	0.03 (0.14)	0.00 (0.14)	0.02 (0.14)	-0.01 (0.12)
Small empl. / self empl.	-0.12 (0.16)	-0.14 (0.16)	-0.10 (0.16)	0.13 (0.14)
Lower supervisory / tech.	0.16 (0.19)	0.11 (0.19)	0.14 (0.19)	0.18 (0.17)
Semi routine / routine	0.07 (0.15)	0.03 (0.15)	0.06 (0.15)	0.10 (0.13)
No partner in work	1.05 (0.17)***	1.03 (0.17)***	1.04 (0.16)***	0.58 (0.14)***
Housing tenure (ref= owner)				
Rented privately	0.35 (0.22)	0.31 (0.22)	0.36 (0.22)	0.10 (0.19)
Social housing	0.68 (0.14)***	0.60 (0.14)***	0.51 (0.14)***	0.10 (0.12)
Other	-0.17 (0.30)	-0.17 (0.30)	-0.19 (0.30)	-0.14 (0.26)
Neighbourhood exposures				
IMD decile sweep 2 (ref = most deprived)		-0.01 (0.02)	0.01 (0.02)	0.02 (0.02)
Interviewer observations sweep 2 (ref = most favourable)				
Second		0.00 (0.13)		
Third		0.45 (0.14)***		
Fourth		0.47 (0.15)***		
Least favourable		0.37 (0.16)*		
Maternal neighbourhood satisfaction sweep 2 (ref = most satisfied)				
Second quintile			0.30 (0.13)*	0.14 (0.11)
Third quintile			0.41 (0.13)**	0.14 (0.11)
Fourth quintile			0.68 (0.14)***	0.30 (0.12)*
Least satisfied			1.32 (0.15)***	0.58 (0.13)***
Kessler-6 score, sweep two				0.52 (0.01)***
Constant	2.30 (0.37)	1.99 (0.41)	1.67 (0.40)	0.45 (0.35)
Neighbourhood variance	0.11 (0.13)^{NS}	0.09 (0.13)^{NS}	0.10 (0.13)^{NS}	0.09 (0.09)^{NS}
% of total neighbourhood variance explained	80.4	83.9	82.1	83.9
Residual variance	12.64 (0.24)	12.62 (0.24)	12.51 (0.24)	9.42 (0.18)
Total variance	12.75	12.71	12.61	9.51
VPC	0.9	0.7	0.8	0.9

*** p < 0.001 ** p < 0.01 *p < 0.05 ^{NS} Random effect not statistically significant

6.3.3 Sensitivity analysis

Because of the skewed distribution of the Kessler-6 score, the previous analyses were run also with psychological distress coded as a binary variable. The cut-off point was chosen at above 7 points on the scale, which identified the top 10% of the sample. This cut-point was shown to be associated with a significantly increased probability of caseness when screening for mental illness (Furukawa et al., 2003). The conclusions regarding the main relationships did not change: cross-sectionally as well as longitudinally low maternal neighbourhood satisfaction, both at the individual and the neighbourhood level, was linearly associated with higher odds of being distressed (or among the top 10% of the distribution), while associations with interviewer observations were less strong and statistically significant only for the fourth quintile.

6.3.4 Summary

The results of the multilevel models are summarised in Table 6-10. In the cross-sectional as well as the longitudinal analyses, maternal neighbourhood satisfaction was significantly associated with levels of psychological distress, after allowing for family socio-economic background characteristics. The relationship was linear, that is, the least satisfied the mother was with the area she lived in, the higher was – on average – the level of distress she experienced. In line with these findings, the results of the longitudinal analyses suggest that given equal baseline levels of distress, mothers who had been dissatisfied with their neighbourhood at sweep two experienced a slight increase in their levels of psychological distress over the following 4-5 years. A statistically significant relationship of similar magnitude was found also with interviewer-observed neighbourhood disorder, making it unlikely that the association was due merely to reverse causation.

Another consistent finding was the association with social housing – living in social housing was related to higher levels of distress and appeared to contribute to negative perceptions of the neighbourhood.

Both cross-sectionally and longitudinally, there was no indication that neighbourhood perceptions accounted for part of the variability in distress levels between neighbourhoods (at least not under the definition of LSOAs and their equivalents in Scotland and NI). The between-neighbourhood variance was explained when family socio-economic characteristics were accounted for.

It is not possible to establish exactly how much of the association between neighbourhood perceptions and maternal psychological distress was due to reverse causality, as adjusting for baseline levels of distress probably downplayed the importance of mother's perceptions. However, the results suggest that mothers' neighbourhood perceptions were at least partly congruent with measures of observed social disorder and did contribute to their experience of psychological distress.

Table 6-10   Summary table of multilevel models predicting maternal psychological distress

		Cross-sectional		**Longitudinal**	
Neighbourhood predictor	Maternal neighbourhood satisfaction	Maternal neighbourhood satisfaction aggregated	Observed neighbourhood disorder	Maternal neighbourhood satisfaction (sweep two)	Observed neighbourhood disorder (sweep two)
Outcome		Kessler-6 score, sweep two		Kessler-6 score, sweep four	
VPC (%), unadjusted		5.0		4.1	
VPC (%), adjusted	1.4	0.9	1.1	0.9	0.7
Regression coefficient for "Bottom quintile" of neighbourhood predictor (ref = Top quintile)[1]	1.40 (0.14)***	0.85 (0.20)***	0.45 (0.15)***	0.58 (0.13)***	0.37 (0.16)*
Evidence for neighbourhood characteristics /perceptions contributing to the between-neighbourhood variability in levels of maternal psychological distress?		No		No	

[1] Fully adjusted model

6.4 Do parenting practices differ across neighbourhoods?

The results from the previous section suggest that mothers' perceptions of their neighbourhood contributed to their experience of psychological distress.

Part two of this chapter used data from sweep two to investigate whether and how much parenting practices varied across neighbourhoods over and above compositional effects, and whether maternal levels of psychological distress contributed to associations between neighbourhood characteristics and parenting.

6.4.1 Analytical strategy

The bivariate analyses have shown that parenting practices were associated with levels of maternal distress as well as neighbourhood characteristics. The degree to which categorical outcomes vary across neighbourhoods net of family-level confounding factors, and whether neighbourhood characteristics contribute to this variability, can be estimated using two-level binary response models[1]. Note that in a multilevel binary response model the within-neighbourhood variance or level-1 variance is fixed at 3.29. The Variance Partition Coefficient for a binary response model is interpreted as the proportion of the total residual variance in the propensity to be in response category 1 (versus 0) that is due to differences between groups (Steele, 2008). The coefficients for the covariates produced by the model are presented as odds ratios for easier interpretation, however the between-neighbourhood variance is on the log-odds scale.

Analysis samples and neighbourhood predictors

All measures stemmed from sweep two. The analysis samples consisted of mothers who had been residentially stable between sweeps one and two and for whom all information was complete. The final sample sizes were 7,936 for daily reading and regular bedtimes (within 2,291 LSOAs); 7,827 for smacking (within 2,282 LSOAs) and 7,788 for daily shouting (within 2,275 LSOAs). The average number of observations per LSOA was 3.5 for daily reading and regular bedtimes, and 3.4 for smacking and daily shouting.

Neighbourhood predictors were IMD, maternal neighbourhood satisfaction measured at the individual level and interviewer observations of neighbourhood disorder.

[1] Multilevel binary response models are explained in more detail in chapter five, section 5.2.4.

Covariates

As covariates were included: MCS design strata; child gender; child age in months; weekly family income as a continuous variable (scaled so that 1 unit corresponded to £100 per week); NS-SEC of either mother or partner, whichever was higher; housing tenure; maternal education (NVQ level); maternal age in years; family structure; maternal ethnicity and the number of children in the household.

Multilevel models

For each parenting outcome, a sequence of four models was estimated:

Model A was the empty model, estimating the variance between neighbourhoods before any explanatory variables were taken into account.

Model B adjusted for MCS strata and individual level covariates only.

Model C adjusted for MCS strata, individual level covariates, IMD, maternal neighbourhood satisfaction and interviewer observed neighbourhood disorder.

Model D additionally adjusted for maternal psychological distress.

6.4.2 Daily reading

The empty model or variance components model (Model A, Table 6-11) shows that there was statistically significant variation between neighbourhoods in whether children were being read to on a daily basis. The VPC was 0.101, so in this sample, approximately 10% of the overall variation in the probability of being read to daily was between neighbourhoods. The odds of being read to daily for a child aged three in an "average" neighbourhood were 1.56, which can be expressed as a probability using the formula

probability = odds / (1+odds) = 61%.

This is just another way of arriving at an estimate for the overall percentage of children in the sample who were read to daily, but which takes the clustering of the data into account.

After allowing for the influence of the family level covariates, the between-neighbourhood variance was reduced by two-thirds (Model B in Table 6-12). The odds of being read to daily were higher for girls than for boys. Maternal education was strongly and positively associated with daily reading. Other socio-demographic factors associated with higher odds of daily reading were higher maternal age, the presence of two parents and fewer children in the household. There was no statistically significant relationship with family income net of the other family background factors. In terms of ethnicity, Indian, Black Caribbean and Black African mothers were less likely to read daily compared to White mothers[1].

Model C in Table 6-12 then additionally adjusted for the neighbourhood exposures. Neighbourhood deprivation measured via the IMD was significantly and strongly associated with the outcome in the expected direction. The relationship with maternal neighbourhood satisfaction was weak and not linear. Only mothers belonging to the third quintile were significantly less likely to read daily than mothers in the top (most satisfied) quintile. There was also a weak nonlinear association with interviewer observed neighbourhood disorder: mothers living in neighbourhoods that had been rated most favourably were slightly more likely to read daily than mothers in other neighbourhoods. The odds ratios for the three neighbourhood variables were similar when they were entered into the model separately – there was no evidence of mediation (data not shown). The inclusion of the neighbourhood variables led to a slight reduction in the between-neighbourhood variance.

Distressed mothers were less likely to read daily (Model D in Table 6-12). Adding maternal distress into the model did however not lead to important changes in the relationship with the neighbourhood factors, nor did it help to explain more of the neighbourhood variability. There was still significant variation between neighbourhoods in the fully adjusted model, with an estimated 3.2% of the unexplained variance due to factors operating at the neighbourhood level.

Table 6-11 Variance Components Model (Model A) estimating the variability between neighbourhoods in the probability of being read to daily, sweep two (child age 3), N = 7,936

	Estimate (95% Confidence Interval)
Constant	1.56 (1.48, 1.65)***
Between-neighbourhood variance	0.37 (0.28, 0.50)***
Total variance (between-neighbourhood + 3.29)	3.66
% of total variance due to differences between neighbourhoods	**10.1**

*** p < 0.001

[1] This is different from the bivariate analyses, which suggested that Bangladeshi and Black African were less likely to read daily.

Table 6-12 Results of multilevel binary response models predicting odds ratios for "Daily reading" at sweep two (N = 7,936)

	Odds Ratio (95% Confidence Interval)		
	Model B	**Model C**	**Model D**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	0.76 (0.66, 0.88)***	0.93 (0.79, 1.10)	0.93 (0.78, 1.10)
England – ethnic	0.69 (0.53, 0.89)**	0.86 (0.66, 1.13)	0.85 (0.65, 1.12)
Wales – advantaged	0.90 (0.70, 1.15)	0.84 (0.66, 1.08)	0.84 (0.65, 1.08)
Wales – disadvantaged	0.81 (0.67, 0.97)*	0.93 (0.77, 1.13)	0.93 (0.77, 1.13)
Scotland – advantaged	0.97 (0.78, 1.21)	0.95 (0.77, 1.19)	0.95 (0.76, 1.18)
Scotland – disadvantaged	0.78 (0.63, 0.98)*	0.91 (0.72, 1.14)	0.91 (0.72, 1.15)
NI – advantaged	0.76 (0.58, 1.00)*	0.71 (0.54, 0.92)*	0.70 (0.54, 0.92)**
NI – disadvantaged	0.82 (0.64, 1.06)	0.98 (0.75, 1.28)	0.98 (0.75, 1.28)
Individual level covariates			
Girl	1.21 (1.10, 1.33)***	1.21 (1.10, 1.34)***	1.21 (1.10, 1.33)***
Child age (months)	0.98 (0.96, 1.01)	0.98 (0.96, 1.01)	0.98 (0.96, 1.01)
Weekly family income, per £100	1.01 (0.98, 1.04)	0.99 (0.97, 1.02)	0.99 (0.96, 1.02)
NS-SEC (ref= manag. / prof.)			
Intermediate	0.87 (0.73, 1.03)	0.88 (0.74, 1.05)	0.88 (0.74, 1.05)
Small empl. / self empl.	0.82 (0.67, 1.01)	0.82 (0.67, 1.01)	0.81 (0.66, 1.00)
Lower supervisory / tech.	0.88 (0.72, 1.07)	0.90 (0.74, 1.10)	0.90 (0.74, 1.10)
Semi routine / routine	0.74 (0.63, 0.88)**	0.77 (0.65, 0.91)**	0.77 (0.65, 0.91)**
No parent in work	0.92 (0.76, 1.11)	0.93 (0.77, 1.12)	0.94 (0.78, 1.13)
Housing tenure (ref= owner)			
Rented privately	1.11 (0.86, 1.42)	1.12 (0.87, 1.45)	1.15 (0.89, 1.48)
Social housing	0.82 (0.70, 0.96)*	0.87 (0.74, 1.02)	0.88 (0.75, 1.04)
Other	0.91 (0.69, 1.21)	0.92 (0.69, 1.22)	0.92 (0.69, 1.23)
Maternal NVQ (ref = level 4/5)			
Level 3	0.72 (0.62, 0.84)***	0.74 (0.63, 0.86)***	0.74 (0.63, 0.86)***
Level 2	0.51 (0.44, 0.58)***	0.52 (0.46, 0.60)***	0.52 (0.45, 0.60)***
Level 1	0.42 (0.34, 0.52)***	0.44 (0.36, 0.54)***	0.44 (0.35, 0.54)***
Overseas	0.47 (0.32, 0.69)***	0.49 (0.34, 0.72)***	0.50 (0.34, 0.73)***
None	0.35 (0.28, 0.42)***	0.36 (0.30, 0.45)***	0.37 (0.30, 0.45)***
Maternal age (years)	1.02 (1.01, 1.03)***	1.02 (1.01, 1.03)**	1.02 (1.01, 1.03)***
Family structure (ref = both natural parents			
Natural mother / other partner	0.74 (0.50, 1.10)	0.75 (0.51, 1.11)	0.76 (0.52, 1.12)
Single mother	0.82 (0.69, 0.98)*	0.82 (0.69, 0.99)*	0.83 (0.70, 1.00)*

Table 6-12 (continued)

	Odds Ratio (95% Confidence Interval)		
	Model B	**Model C**	**Model D**
Maternal ethnicity (ref = White)			
Mixed	0.78 (0.43, 1.39)	0.78 (0.44, 1.40)	0.79 (0.44, 1.41)
Indian	0.36 (0.24, 0.55)***	0.37 (0.25, 0.56)***	0.38 (0.25, 0.57)***
Pakistani	0.81 (0.56, 1.16)	0.83 (0.58, 1.19)	0.87 (0.60, 1.26)
Bangladeshi	0.62 (0.31, 1.27)	0.66 (0.33, 1.34)	0.67 (0.33, 1.36)
Black Caribbean	0.52 (0.33, 0.82)**	0.53 (0.34, 0.84)**	0.53 (0.34, 0.84)**
Black African	0.34 (0.21, 0.57)***	0.36 (0.22, 0.60)***	0.36 (0.22, 0.60)***
Other	0.73 (0.55, 0.96)*	0.73 (0.55, 0.97)*	0.74 (0.56, 0.98)*
Number of children (ref = one)			
Two	0.64 (0.56, 0.73)***	0.63 (0.55, 0.72)***	0.63 (0.55, 0.72)***
Three	0.44 (0.37, 0.51)***	0.43 (0.36, 0.50)***	0.43 (0.36, 0.50)***
Four	0.42 (0.34, 0.53)***	0.42 (0.33, 0.52)***	0.41 (0.33, 0.52)***
Five or more	0.28 (0.20, 0.39)***	0.27 (0.19, 0.38)***	0.27 (0.19, 0.39)***
Neighbourhood exposures			
IMD decile (ref = least deprived)		0.95 (0.92, 0.97)***	0.95 (0.92, 0.97)***
Maternal neighbourhood satisfaction (ref = most satisfied)			
Second quintile		0.88 (0.75, 1.04)	0.89 (0.75, 1.05)
Third quintile		0.78 (0.66, 0.92)**	0.78 (0.66, 0.93)**
Fourth quintile		0.86 (0.73, 1.02)	0.88 (0.74, 1.04)
Least satisfied		0.88 (0.73, 1.06)	0.91 (0.76, 1.09)
Interviewer observations (ref = most favourable)			
Second		0.91 (0.77, 1.08)	0.91 (0.77, 1.08)
Third		0.81 (0.69, 0.96)*	0.82 (0.69, 0.97)*
Fourth		0.83 (0.69, 0.99)*	0.83 (0.70, 0.99)*
Least favourable		0.88 (0.73, 1.07)	0.89 (0.73, 1.07)
Maternal psychological distress (Kessler-6 score, cont.)			0.98 (0.96, 0.99)**
Constant	5.21 (1.88, 14.41)	9.45 (3.35, 26.63)	9.96 (3.53, 28.10)
Between neighbourhood variance	0.12 (0.06, 0.24)**	0.10 (0.04, 0.23)**	0.11 (0.05, 0.23)**
% of total neighbourhood variance explained	67.6	73.0	70.3
Total variance	3.41	3.39	3.40
% of unexplained variance due to neighbourhoods (VPC)	3.5	2.9	3.2

*** p < 0.001 ** p < 0.01 *p < 0.05

6.4.3 Regular bedtime

For "Regular bedtime", the response was coded as "1" if the mother reported that the child had always or usually a regular bedtime, and as "0" if the answer was "never / almost never" or "sometimes". Table 6-13 shows the results of the variance components (or empty) model. The odds for a child in an average neighbourhood of having a regular bedtime were 4.5, which translates into a probability of 82%. About 8% of the total variance in the probability of having a regular bedtime was due to differences between neighbourhoods.

Table 6-13 Variance Components Model (Model A) estimating the variability between neighbourhoods in the probability of regular bedtimes, sweep two (child age 3), N = 7,936.

	Estimate (95% Confidence Interval)
Constant	4.51 (4.19, 4.85)***
Between-neighbourhood variance	0.30 (0.19, 0.46)***
Total variance (between-neighbourhood + 3.29)	3.59
% of total variance due to differences between neighbourhoods	**8.4**

*** p < 0.001

The odds of having a regular bedtime were higher for children who were older, whose mothers were more educated, whose families had higher incomes and belonged to a higher social class, and whose mothers were older (Model B in Table 6-14). Children of Black African mothers were less likely to have regular bedtimes compared to White mothers. In this model, the between-neighbourhood variability had lost statistical significance.

After adjusting for the covariates, children in more deprived neighbourhoods were less likely to have a regular bedtime than children in less deprived areas (Model C in Table 6-14). Maternal neighbourhood satisfaction was not at all associated with the outcome. Children living in neighbourhoods rated least favourable by the interviewers were also less likely to have a regular bedtime, however the association with observed neighbourhood disorder was not linear.

Again, while maternal psychological distress was strongly and negatively associated with the outcome, there was no indication that this was driving the between-neighbourhood variability or relationships with the neighbourhood variables (Model D in Table 6-14).

Table 6-14 Results of multilevel binary response models predicting odds ratios for "Regular bedtimes" at sweep two (N = 7,936)

	Odds Ratio (95% Confidence Interval)		
	Model B	**Model C**	**Model D**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	0.73 (0.61, 0.86)***	0.88 (0.72, 1.06)	0.87 (0.71, 1.06)
England – ethnic	0.75 (0.57, 0.99)*	0.94 (0.69, 1.27)	0.92 (0.68, 1.25)
Wales – advantaged	0.95 (0.70, 1.30)	0.90 (0.66, 1.24)	0.90 (0.66, 1.23)
Wales – disadvantaged	0.60 (0.49, 0.74)***	0.69 (0.56, 0.86)**	0.69 (0.55, 0.86)**
Scotland – advantaged	1.24 (0.93, 1.67)	1.21 (0.90, 1.63)	1.20 (0.89, 1.61)
Scotland – disadvantaged	0.82 (0.63, 1.07)	0.96 (0.73, 1.26)	0.96 (0.73, 1.26)
NI – advantaged	0.93 (0.66, 1.30)	0.86 (0.61, 1.20)	0.84 (0.60, 1.17)
NI – disadvantaged	0.76 (0.57, 1.01)	0.88 (0.66, 1.19)	0.89 (0.66, 1.20)
Individual level covariates			
Girl	1.05 (0.93, 1.18)	1.05 (0.93, 1.18)	1.04 (0.93, 1.17)
Child age (months)	1.05 (1.02, 1.08)**	1.05 (1.02, 1.08)**	1.05 (1.02, 1.08)**
Weekly family income, per £100	1.07 (1.03, 1.11)***	1.05 (1.01, 1.09)**	1.05 (1.01, 1.09)*
NS-SEC (ref= manag. / prof.)			
Intermediate	0.80 (0.65, 0.99)*	0.81 (0.66, 1.01)	0.81 (0.66, 1.01)
Small empl. / self empl.	0.75 (0.58, 0.96)*	0.75 (0.59, 0.97)*	0.74 (0.58, 0.95)*
Lower supervisory / tech.	0.79 (0.62, 1.01)	0.82 (0.65, 1.05)	0.83 (0.65, 1.05)
Semi routine / routine	0.65 (0.54, 0.80)***	0.68 (0.56, 0.83)***	0.67 (0.55, 0.82)***
No parent in work	0.68 (0.54, 0.84)**	0.69 (0.55, 0.86)**	0.70 (0.56, 0.88)**
Housing tenure (ref= owner)			
Rented privately	0.96 (0.72, 1.28)	0.99 (0.74, 1.32)	1.02 (0.76, 1.37)
Social housing	0.67 (0.56, 0.79)***	0.72 (0.60, 0.86)***	0.74 (0.62, 0.88)**
Other	0.65 (0.47, 0.89)**	0.66 (0.48, 0.90)*	0.66 (0.48, 0.90)**
Maternal NVQ (ref = level 4/5)			
Level 3	0.80 (0.65, 0.98)*	0.82 (0.67, 1.01)	0.82 (0.67, 1.01)
Level 2	0.63 (0.53, 0.74)***	0.65 (0.54, 0.77)***	0.64 (0.54, 0.77)***
Level 1	0.49 (0.39, 0.62)***	0.51 (0.41, 0.65)***	0.51 (0.40, 0.65)***
Overseas	0.46 (0.31, 0.69)***	0.48 (0.32, 0.72)***	0.49 (0.33, 0.74)**
None	0.43 (0.34, 0.54)***	0.45 (0.36, 0.56)***	0.46 (0.36, 0.57)***
Maternal age (years)	0.98 (0.97, 0.99)***	0.97 (0.96, 0.99)***	0.97 (0.96, 0.99)
Family structure (ref = both natural parents			
Natural mother / other partner	1.14 (0.74, 1.75)	1.16 (0.76, 1.79)	1.18 (0.77, 1.82)
Single mother	1.36 (1.11, 1.67)**	1.37 (1.12, 1.67)**	1.39 (1.14, 1.71)**

Table 6-14 (continued)

	Odds Ratio (95% Confidence Interval)		
	Model B	**Model C**	**Model D**
Maternal ethnicity (ref = White)			
Mixed	0.68 (0.36, 1.26)	0.69 (0.37, 1.28)	0.69 (0.37, 1.30)
Indian	0.71 (0.44, 1.14)	0.74 (0.46, 1.19)	0.78 (0.48, 1.25)
Pakistani	0.72 (0.49, 1.05)	0.75 (0.51, 1.10)	0.82 (0.56, 1.21)
Bangladeshi	0.65 (0.32, 1.33)	0.69 (0.34, 1.40)	0.71 (0.35, 1.44)
Black Caribbean	0.70 (0.43, 1.15)	0.72 (0.44, 1.18)	0.72 (0.44, 1.18)
Black African	0.34 (0.21, 0.55)***	0.36 (0.22, 0.58)***	0.36 (0.22, 0.58)***
Other	0.70 (0.52, 0.95)*	0.71 (0.52, 0.97)*	0.72 (0.53, 0.98)*
Number of children (ref = one)			
Two	1.50 (1.29, 1.75)***	1.49 (1.28, 1.73)***	1.49 (1.28, 1.74)***
Three	1.24 (1.03, 1.49)*	1.23 (1.02, 1.48)*	1.23 (1.02, 1.48)*
Four	1.15 (0.90, 1.47)	1.14 (0.89, 1.47)	1.14 (0.89, 1.46)
Five or more	0.76 (0.54, 1.06)	0.77 (0.55, 1.08)	0.78 (0.55, 1.09)
Neighbourhood exposures			
IMD decile (ref = least deprived)		0.96 (0.93, 0.99)**	0.96 (0.92, 0.99)**
Maternal neighbourhood satisfaction (ref = most satisfied)			
Second quintile		1.13 (0.91, 1.40)	1.15 (0.93, 1.42)
Third quintile		0.93 (0.76, 1.15)	0.95 (0.77, 1.17)
Fourth quintile		0.90 (0.73, 1.11)	0.94 (0.76, 1.15)
Least satisfied		1.01 (0.81, 1.25)	1.06 (0.85, 1.32)
Interviewer observations (ref = most favourable)			
Second		0.94 (0.75, 1.18)	0.93 (0.75, 1.17)
Third		0.86 (0.69, 1.07)	0.87 (0.70, 1.09)
Fourth		0.71 (0.57, 0.89)**	0.71 (0.57, 0.89)**
Least favourable		0.78 (0.62, 0.99)*	0.79 (0.62, 1.00)*
Maternal psychological distress (Kessler-6 score, cont.)			0.96 (0.95, 0.98)***
Constant	2.33 (0.67, 8.10)	3.79 (1.06, 13.53)	4.04 (1.13, 14.44)
Between neighbourhood variance	0.03 (0.00, 0.89)[NS]	0.03 (0.00, 1.17)[NS]	0.02 (0.00, 5.82)[NS]
% of total neighbourhood variance explained	90.0	90.0	93.3
Total variance	3.32	3.32	3.31
% of unexplained variance due to neighbourhoods (VPC)	0.9	0.9	0.6

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ [NS] Random effect not statistically significant

6.4.4 Smacking

For "Smacking", a score of 1 was given if the mother reported to use smacking as a discipline strategy at all, and a score of 0 if she reported to never smack her child. In the average neighbourhood, the probability for a 3-year-old child of being smacked at all was 67%, calculated from baseline odds of 2.06 (Table 6-15). Differences between neighbourhoods accounted for 3.5% of the overall variance in the outcome.

Table 6-15 Variance Components Model (Model A) estimating the variability between neighbourhoods in the probability of smacking, sweep two (child age 3), N = 7,827

	Estimate (95% Confidence Interval)
Constant	2.06 (1.95, 2.17)***
Between-neighbourhood variance	0.12 (0.06, 0.24)***
Total variance (between-neighbourhood + 3.29)	3.41
% of total variance due to differences between neighbourhoods	**3.5**

*** p < 0.001

Model B in Table 6-16 shows the associations with the covariates. Girls were less likely to be exposed to smacking than boys. The association with maternal education was not linear, however mothers with the highest level of education were the least likely to smack. A higher family income, higher maternal age and lone parent status were also associated with lower odds of smacking. Pakistani mothers were less likely to use smacking, while Black Caribbean and Black African mothers were more likely to smack than White mothers. After adjusting for the covariates, the between-neighbourhood variance was no longer statistically significant.

Lower neighbourhood satisfaction was associated with higher odds of smacking, although again the relationship was not linear and notably there was no statistically significant difference between mothers belonging to the top and the bottom quintile (Model C in Table 6-16). Neither area deprivation nor interviewer observations of social disorder were independently related to the outcome.

Mothers who experienced psychological distress were more likely to smack their children (Model D in Table 6-16), however introducing maternal distress into the model changed the odds ratios for the neighbourhood satisfaction variable only very slightly.

Table 6-16 Results of multilevel binary response models predicting odds ratios for "Smacking" at sweep two (N = 7,827)

	Odds Ratio (95% Confidence Interval)		
	Model B	**Model C**	**Model D**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	0.98 (0.85, 1.13)	0.92 (0.78, 1.08)	0.92 (0.78, 1.08)
England – ethnic	0.90 (0.70, 1.16)	0.84 (0.64, 1.10)	0.85 (0.65, 1.11)
Wales – advantaged	0.96 (0.76, 1.21)	0.99 (0.78, 1.25)	0.99 (0.78, 1.25)
Wales – disadvantaged	0.85 (0.71, 1.01)	0.81 (0.67, 0.98)*	0.81 (0.67, 0.98)
Scotland – advantaged	1.10 (0.90, 1.36)	1.13 (0.92, 1.38)	1.13 (0.92, 1.39)
Scotland – disadvantaged	0.95 (0.77, 1.18)	0.90 (0.72, 1.13)	0.90 (0.72, 1.13)
NI – advantaged	1.49 (1.14, 1.96)**	1.56 (1.19, 2.05)**	1.58 (1.20, 2.07)**
NI – disadvantaged	1.30 (1.00, 1.68)*	1.25 (0.95, 1.64)	1.24 (0.94, 1.63)
Individual level covariates			
Girl	0.77 (0.70, 0.85)***	0.77 (0.70, 0.85)***	0.77 (0.70, 0.85)***
Child age (months)	0.98 (0.95, 1.00)	0.98 (0.95, 1.00)	0.98 (0.95, 1.00)
Weekly family income, per £100	0.96 (0.93, 0.98)**	0.96 (0.94, 0.99)**	0.97 (0.94, 0.99)*
NS-SEC (ref= manag. / prof.)			
Intermediate	1.15 (0.97, 1.37)	1.14 (0.96, 1.36)	1.14 (0.96, 1.36)
Small empl. / self empl.	1.15 (0.93, 1.43)	1.17 (0.94, 1.44)	1.18 (0.95, 1.46)
Lower supervisory / tech.	1.05 (0.86, 1.30)	1.05 (0.85, 1.29)	1.04 (0.85, 1.28)
Semi routine / routine	1.07 (0.90, 1.28)	1.07 (0.90, 1.27)	1.07 (0.90, 1.27)
No parent in work	0.96 (0.80, 1.16)	0.97 (0.80, 1.17)	0.95 (0.79, 1.15)
Housing tenure (ref= owner)			
Rented privately	0.76 (0.59, 0.98)*	0.76 (0.59, 0.98)*	0.74 (0.57, 0.95)*
Social housing	0.88 (0.75, 1.04)	0.87 (0.74, 1.04)	0.85 (0.72, 1.01)
Other	0.80 (0.60, 1.06)	0.80 (0.60, 1.06)	0.80 (0.60, 1.06)
Maternal NVQ (ref = level 4/5)			
Level 3	1.22 (1.05, 1.43)*	1.21 (1.03, 1.41)*	1.21 (1.04, 1.41)*
Level 2	1.38 (1.21, 1.59)***	1.36 (1.19, 1.56)***	1.37 (1.19, 1.57)***
Level 1	1.40 (1.13, 1.73)**	1.37 (1.10, 1.70)**	1.37 (1.10, 1.71)**
Overseas	1.50 (1.01, 2.24)*	1.47 (0.99, 2.20)	1.45 (0.97, 2.17)
None	1.04 (0.85, 1.28)	1.03 (0.84, 1.26)	1.01 (0.82, 1.24)
Maternal age (years)	0.98 (0.97, 0.99)***	0.98 (0.97, 0.99)***	0.98 (0.97, 0.99)***
Family structure (ref = both natural parents			
Natural mother / other partner	0.69 (0.47, 1.01)	0.68 (0.46, 0.99)*	0.67 (0.45, 0.98)*
Single mother	0.83 (0.70, 1.00)*	0.84 (0.70, 1.00)	0.83 (0.69, 0.99)*

Table 6-16 (continued)

	Odds Ratio (95% Confidence Interval)		
	Model B	**Model C**	**Model D**
Maternal ethnicity (ref = White)			
Mixed	1.66 (0.88, 3.13)	1.66 (0.88, 3.12)	1.65 (0.88, 3.11)
Indian	1.21 (0.79, 1.84)	1.19 (0.78, 1.82)	1.15 (0.75, 1.76)
Pakistani	0.50 (0.35, 0.72)***	0.51 (0.36, 0.73)***	0.47 (0.33, 0.68)***
Bangladeshi	0.49 (0.25, 0.95)*	0.48 (0.25, 0.93)*	0.47 (0.24, 0.91)*
Black Caribbean	2.47 (1.44, 4.26)**	2.46 (1.43, 4.24)**	2.49 (1.44, 4.29)**
Black African	1.34 (0.83, 2.18)	1.32 (0.81, 2.15)	1.33 (0.82, 2.18)
Other	0.90 (0.68, 1.18)	0.90 (0.68, 1.19)	0.88 (0.67, 1.17)
Number of children (ref = one)			
Two	1.17 (1.04, 1.33)*	1.19 (1.05, 1.35)**	1.19 (1.05, 1.35)**
Three	1.08 (0.93, 1.27)	1.10 (0.94, 1.29)	1.10 (0.94, 1.29)
Four	0.92 (0.74, 1.16)	0.95 (0.76, 1.18)	0.95 (0.76, 1.19)
Five or more	0.88 (0.64, 1.22)	0.90 (0.65, 1.25)	0.90 (0.65, 1.25)
Neighbourhood exposures			
IMD decile (ref = least deprived)		1.02 (0.99, 1.04)	1.02 (0.99, 1.04)
Maternal neighbourhood satisfaction (ref = most satisfied)			
Second quintile		1.25 (1.07, 1.47)**	1.24 (1.06, 1.45)**
Third quintile		1.26 (1.07, 1.48)**	1.24 (1.06, 1.46)**
Fourth quintile		1.24 (1.05, 1.46)*	1.21 (1.02, 1.42)*
Least satisfied		1.16 (0.97, 1.39)	1.11 (0.93, 1.33)
Interviewer observations (ref = most favourable)			
Second		0.98 (0.84, 1.15)	0.99 (0.84, 1.15)
Third		1.07 (0.91, 1.26)	1.06 (0.90, 1.25)
Fourth		1.10 (0.93, 1.31)	1.09 (0.92, 1.30)
Least favourable		0.96 (0.80, 1.16)	0.95 (0.79, 1.15)
Maternal psychological distress (Kessler-6 score, cont.)			1.03 (1.02, 1.05)***
Constant	10.74 (3.94, 29.22)	7.98 (2.88, 22.12)	7.40 (2.67, 20.56)
Between neighbourhood variance	0.06 (0.01, 0.21)[NS]	0.05 (0.01, 0.21)[NS]	0.06 (0.02, 0.21)[NS]
% of total neighbourhood variance explained	50	58.3	50
Total variance	3.35	3.34	3.35
% of unexplained variance due to neighbourhoods (VPC)	1.8	1.5	1.8

*** p < 0.001 ** p < 0.01 *p < 0.05 [NS] Random effect not statistically significant

6.4.5 Daily shouting

According to the results of the variance components model (Model A in Table 6-17), the odds for a mother to be shouting daily in an average neighbourhood were 0.20, which can be expressed as a probability of 17%. The percentage of the overall variance due to differences between neighbourhoods was 3.3%, and the variability between neighbourhoods was marginally statistically significant.

Table 6-17 Variance Components Model (Model A) estimating the variability between neighbourhoods in the probability of daily shouting, sweep two (child age 3), N = 7,788

	Estimate (95% Confidence Interval)
Constant	0.20 (0.19, 0.22)***
Between-neighbourhood variance	0.11 (0.04, 0.30)*
Total variance (between-neighbourhood + 3.29)	3.31
% of total variance due to differences between neighbourhoods	**3.3**

*** $p < 0.001$ *$p < 0.05$

Regarding the relationships with family level covariates there were some similarities with the use of smacking (Model B in Table 6-18). Girls were less likely to be shouted at daily than boys, and again a higher family income, higher level of maternal education and higher maternal age were associated with lower odds of daily shouting. After allowing for the family socio-demographic characteristics, the between-neighbourhood variance was reduced and no longer statistically significant.

Model C in Table 6-18 shows that none of the neighbourhood variables was associated with daily shouting. The relationship with maternal psychological distress was quite strong. For each point increase in the Kessler-6 scale, the odds of daily shouting increased by 9% (Model D in Table 6-18). However, levels of maternal distress did not contribute towards explaining the between-neighbourhood variability in daily shouting.

Table 6-18 Results of multilevel binary response models predicting odds ratios for "Shouting daily" at sweep two (N = 7,788)

	Odds Ratio (95% Confidence Interval)		
	Model B	**Model C**	**Model D**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	1.01 (0.85, 1.21)	0.93 (0.76, 1.14)	0.94 (0.77, 1.16)
England – ethnic	1.22 (0.89, 1.67)	1.09 (0.78, 1.52)	1.13 (0.81, 1.58)
Wales – advantaged	1.11 (0.83, 1.49)	1.12 (0.83, 1.51)	1.11 (0.82, 1.50)
Wales – disadvantaged	1.00 (0.80, 1.24)	0.93 (0.73, 1.17)	0.92 (0.73, 1.17)
Scotland – advantaged	0.92 (0.70, 1.20)	0.93 (0.71, 1.22)	0.95 (0.72, 1.25)
Scotland – disadvantaged	1.15 (0.88, 1.49)	1.07 (0.82, 1.41)	1.06 (0.80, 1.40)
NI – advantaged	1.22 (0.89, 1.68)	1.26 (0.92, 1.73)	1.32 (0.95, 1.81)
NI – disadvantaged	1.09 (0.81, 1.47)	1.03 (0.75, 1.40)	0.99 (0.72, 1.36)
Individual level covariates			
Girl	0.77 (0.69, 0.87)***	0.77 (0.69, 0.87)***	0.78 (0.69, 0.89)***
Child age (months)	0.96 (0.92, 0.99)**	0.96 (0.92, 0.99)**	0.96 (0.92, 0.99)**
Weekly family income, per £100	0.93 (0.89, 0.96)***	0.93 (0.90, 0.97)***	0.94 (0.91, 0.98)**
NS-SEC (ref= manag. / prof.)			
Intermediate	0.90 (0.73, 1.12)	0.91 (0.73, 1.12)	0.90 (0.72, 1.12)
Small empl. / self empl.	1.04 (0.81, 1.34)	1.04 (0.80, 1.34)	1.08 (0.83, 1.40)
Lower supervisory / tech.	1.00 (0.78, 1.27)	0.98 (0.77, 1.26)	0.97 (0.76, 1.24)
Semi routine / routine	0.97 (0.79, 1.19)	0.96 (0.78, 1.18)	0.96 (0.78, 1.19)
No parent in work	1.06 (0.84, 1.33)	1.04 (0.83, 1.31)	0.99 (0.79, 1.25)
Housing tenure (ref= owner)			
Rented privately	0.96 (0.71, 1.31)	0.95 (0.70, 1.29)	0.86 (0.63, 1.18)
Social housing	1.10 (0.91, 1.33)	1.04 (0.85, 1.26)	0.95 (0.78, 1.16)
Other	0.80 (0.56, 1.14)	0.79 (0.55, 1.14)	0.79 (0.55, 1.14)
Maternal NVQ (ref = level 4/5)			
Level 3	1.39 (1.15, 1.69)**	1.37 (1.13, 1.67)**	1.38 (1.13, 1.67)**
Level 2	1.36 (1.14, 1.62)**	1.34 (1.13, 1.60)**	1.35 (1.13, 1.61)**
Level 1	1.39 (1.08, 1.79)*	1.36 (1.05, 1.75)*	1.38 (1.06, 1.78)*
Overseas	1.59 (1.02, 2.49)*	1.56 (1.00, 2.43)	1.48 (0.94, 2.33)
None	1.39 (1.09, 1.78)**	1.36 (1.06, 1.74)*	1.31 (1.02, 1.69)*
Maternal age (years)	0.97 (0.95, 0.98)***	0.97 (0.95, 0.98)***	0.97 (0.95, 0.98)***
Family structure (ref = both natural parents			
Natural mother / other partner	0.99 (0.63, 1.57)	0.98 (0.62, 1.56)	0.97 (0.61, 1.55)
Single mother	1.01 (0.82, 1.26)	1.01 (0.82, 1.26)	0.97 (0.78, 1.21)

Table 6-18 (continued)

	Odds Ratio (95% Confidence Interval)		
	Model B	**Model C**	**Model D**
Maternal ethnicity (ref = White)			
Mixed	0.97 (0.49, 1.93)	0.95 (0.48, 1.90)	0.94 (0.47, 1.89)
Indian	0.66 (0.37, 1.18)	0.64 (0.36, 1.15)	0.54 (0.30, 0.99)*
Pakistani	0.80 (0.51, 1.24)	0.76 (0.49, 1.19)	0.59 (0.38, 0.94)*
Bangladeshi	1.02 (0.45, 2.28)	0.97 (0.43, 2.18)	0.89 (0.39, 2.02)
Black Caribbean	0.57 (0.30, 1.09)	0.56 (0.29, 1.07)	0.56 (0.29, 1.07)
Black African	0.64 (0.32, 1.26)	0.62 (0.31, 1.23)	0.60 (0.30, 1.20)
Other	0.79 (0.55, 1.14)	0.79 (0.55, 1.13)	0.73 (0.51, 1.06)
Number of children (ref = one)			
Two	1.47 (1.25, 1.72)***	1.47 (1.25, 1.73)***	1.47 (1.24, 1.73)***
Three	1.22 (0.99, 1.49)	1.22 (0.99, 1.49)	1.20 (0.98, 1.48)
Four	1.24 (0.94, 1.65)	1.24 (0.93, 1.65)	1.25 (0.93, 1.66)
Five or more	1.03 (0.67, 1.59)	1.01 (0.65, 1.55)	0.96 (0.62, 1.48)
Neighbourhood exposures			
IMD decile (ref = least deprived)		1.02 (0.98, 1.05)	1.02 (0.98, 1.05)
Maternal neighbourhood satisfaction (ref = most satisfied)			
Second quintile		1.08 (0.87, 1.33)	1.03 (0.84, 1.28)
Third quintile		1.03 (0.84, 1.27)	0.98 (0.79, 1.21)
Fourth quintile		1.01 (0.82, 1.25)	0.93 (0.75, 1.15)
Least satisfied		1.08 (0.86, 1.35)	0.95 (0.76, 1.20)
Interviewer observations (ref = most favourable)			
Second		0.94 (0.76, 1.16)	0.96 (0.77, 1.18)
Third		0.88 (0.71, 1.09)	0.86 (0.69, 1.07)
Fourth		1.16 (0.93, 1.44)	1.14 (0.92, 1.42)
Least favourable		1.11 (0.88, 1.40)	1.10 (0.87, 1.39)
Maternal psychological distress (Kessler-6 score, cont.)			1.09 (1.08, 1.11)***
Constant	3.13 (0.83, 11.86)	2.61 (0.67, 10.11)	2.17 (0.55, 8.58)
Between neighbourhood variance	0.06 (0.01, 0.35)^{NS}	0.06 (0.01, 0.35)^{NS}	0.07 (0.01, 0.36)^{NS}
% of total neighbourhood variance explained	45.5	45.5	36.4
Total variance	3.35	3.35	3.36
% of unexplained variance due to neighbourhoods (VPC)	1.8	1.8	2.1

*** p < 0.001 ** p < 0.01 *p < 0.05 ^{NS} Random effect not statistically significant

6.4.6 Summary

A summary of the findings of this section is given in Table 6-19. The use of the selected parenting practices was socially patterned, but more so for the markers of activities and routines (daily reading and regular bedtimes) than the markers of harsh parenting (smacking and daily shouting). Maternal education was an important predictor for all four aspects of parenting.

For daily reading and regular bedtimes, used here as markers of the home learning environment and consistent family routines, there were initially quite large differences between neighbourhoods. Most of this variability was explained by compositional effects, and a statistically significant between-neighbourhood variance remained only for daily reading. Both outcomes were however independently associated with the degree of neighbourhood deprivation. There was only limited evidence for an association between maternal neighbourhood satisfaction and daily reading, and none at all for an association with regular bedtimes. The relationships with interviewer observations were also weak for these two outcomes.

The variability in harsh parenting practices across neighbourhoods was much smaller than that observed for daily reading and regular bedtimes, and was explained for both outcomes after adjusting for family-level covariates. None of the neighbourhood variables was associated with daily shouting, but lower maternal neighbourhood satisfaction was related to the use of smacking.

All four parenting practices were strongly associated with maternal levels of psychological distress. There was however no evidence that maternal distress was driving the variability in parenting practices between neighbourhoods.

Table 6-19 Summary – results of multilevel binary response models predicting markers of parenting

	Daily reading	**Regular bedtime**	**Smacking**	**Daily shouting**
Baseline probability (unadjusted constant)	61% (1.56)	82% (4.51)	67% (2.06)	17% (0.20)
VPC (%) – empty model	**10.1**	**8.4**	**3.5**	**3.3**
VPC (%) – fully adjusted	**3.2**	**0.6**	**1.8**	**2.1**
Statistically significant between-neighbourhood variance after adjusting for individual-level covariates?	Yes	No	No	No
Evidence that neighbourhood deprivation (IMD) independently associated with the outcome?	Yes	Yes	No	No
Evidence that maternal neighbourhood satisfaction independently associated with the outcome?	Equivocal	No	Yes	No
Evidence that interviewer observed social disorder independently associated with the outcome?	Weak	Equivocal	No	No
Suggestion of indirect pathway via maternal distress?	No	No	No	No

6.5 Chapter summary

The aim of this chapter was to examine whether neighbourhood characteristics influenced levels of maternal psychological distress and parenting behaviours. The variance in maternal psychological distress that was due to differences between neighbourhoods before any adjustments was estimated at about 5%. Most of this variability was explained when family-level socio-demographic characteristics were taken into account.

However, mothers' perceptions of their neighbourhoods contributed to their experience of psychological distress, although the size of the association was small after adjusting for baseline levels of distress. Given the consistency of the results obtained from the cross-sectional and longitudinal analyses, it is unlikely that the association was due to reverse causation. A factor that was associated with both maternal distress and with negative perceptions of the neighbourhood was living in social housing.

The parenting practices that were examined in this chapter were markers of daily activities and routines, and markers of harsh parenting. These two aspects of parenting showed different patterns of relationships with the neighbourhood factors. The markers of activities and family routines ("daily reading" and "regular bedtime") were socially graded with initially quite large differences across neighbourhoods, which were however due mainly to compositional effects. Both these outcomes were associated with the degree of neighbourhood deprivation. The variability in harsh parenting across neighbourhoods was smaller, and there were no associations with the IMD. While lower neighbourhood satisfaction was related to the use of smacking, none of the neighbourhood variables was associated with daily shouting. There was no evidence to support the theory of a mediating role for maternal psychological distress in the relationships between neighbourhood factors and any of the examined parenting behaviours.

In chapters seven and eight, which examine the influence of neighbourhoods on children's socio-emotional and cognitive development, maternal psychological distress will be included in the analyses as a potentially mediating variable. Of the parenting behaviours, only daily reading, regular bedtime and smacking will be taken forward as possible mediators, as for daily shouting there was no between-neighbourhood variability after accounting for family-level covariates and also no associations with any of the neighbourhood variables.

Chapter 7

Results – Socio-emotional development

7 Results – Socio-emotional development

7.1 Chapter overview

This chapter examines the relative importance of neighbourhoods and schools for children's socio-emotional development, addressing the second aim of this thesis. Objectives were (1) to partition the variability in the outcome between neighbourhoods, schools and families, before and after taking family background characteristics into account; (2) to examine whether factors measured at the neighbourhood and school level independently contributed to children's socio-emotional difficulties; (3) to test the hypothesis that maternal psychological distress and parenting were on the pathway between neighbourhood characteristics and children's socio-emotional difficulties; and (4) to test whether associations with neighbourhood characteristics varied by family income and child gender.

The outcome measure was children's Total Difficulties score on the Strength and Difficulties Questionnaire (SDQ)[1], which consists of the following four subscales: emotional, conduct and peer problems, and hyperactivity. The SDQ had been reported at age seven (sweep four) by the mother as well as by a school teacher, and both measures were analysed.

Associations between neighbourhood factors and child outcomes were examined cross-sectionally and longitudinally. The neighbourhood exposures that were considered in the cross-sectional analysis stemmed from sweep four. These were the Index of Multiple Deprivation (IMD), neighbourhood median income and the percentage of social housing in the neighbourhood[2]. The latter was included because there was an indication that living in social housing was associated with more behavioural and emotional difficulties, and it was deemed appropriate to test the relationship between the outcome and the proportion of social housing at the neighbourhood level. Neighbourhood affluence was included because it might have different implications than the composite measure of deprivation, the IMD. The longitudinal analyses examined the associations with maternal neighbourhood

[1] A detailed description of this measure including the differences in mother- and teacher-reported scores has been given in chapter four (section 4.5).

[2] Detailed descriptions of these measures have been given in chapter four (section 4.3.1).

satisfaction and interviewer-observed neighbourhood disorder[1], both measured at sweep two of the MCS, among residentially stable children.

Following descriptive analyses, cross-classified multilevel models were estimated. The exact model specifications are described in the relevant sections.

7.2 Bivariate analyses

All bivariate analyses are based on the maximum number of observations available and were carried out using the MCS survey weights. Teacher reports of socio-emotional difficulties were available only for about two thirds of the overall sample. A comparison of characteristics of the overall sample and the subsample which included only the cases where both mothers and teachers had completed the SDQ (Table 7-1) suggests that the subsample was slightly more advantaged.

7.2.1 Social gradients in children's socio-emotional development

It is well established that children's experience of socio-emotional difficulties is socially graded (Meltzer et al., 2000). Equally in this sample, the percentage of children scoring high on the Total Difficulties scale (belonging to the worst decile of the distribution[2]) was lowest amongst children from the richest fifth of the family income distribution and highest amongst the poorest fifth (Figure 7-1). The gradient was steeper for mother-reported scores, with less than 4% of children from the richest families displaying clinically relevant difficulties compared to about 18% of children from the poorest families. For teacher-reported scores (using a different cut-point), these percentages were about 7% and 18% respectively.

[1] Detailed descriptions of these measures have been given in chapter four (section 4.3.2).

[2] These were children who scored 16 or more points on the mother-reported Total Difficulties scale and 15 or more points on the teacher-reported Total Difficulties scale (see chapter four, section 4.5).

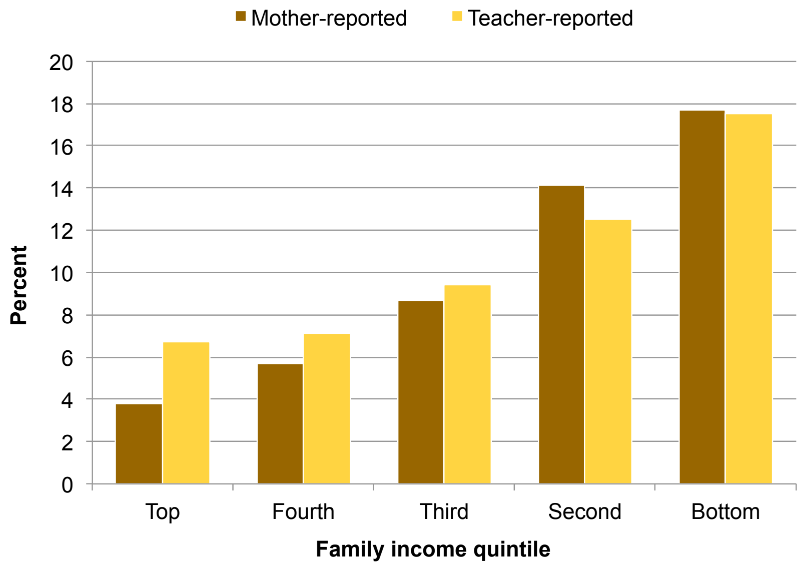

Figure 7-1 Percentage of children with socio-emotional difficulties as reported by the mother (N= 12,766) and the teacher (N= 8,382), by family income quintile

Table 7-1 presents descriptive statistics for both mother- and teacher-reported socio-emotional difficulties by characteristics of the child and family.

Girls were less likely to display socio-emotional difficulties than boys. Children with a statement of special educational needs (SEN) were considerably more often identified as having difficulties by both mothers and teachers, compared to children without SEN statement. Regarding the family's socio-demographic background, children were more likely to have clinically relevant socio-emotional difficulties when their families were poorer, their parents belonged to a lower social class, they lived in social housing, their mothers were younger and less educated, if the family had not been residentially stable, if the family had no friends in the area and if there were no parks or playgrounds in the neighbourhood. Associations with ethnicity appeared to be somewhat dependent on whether the informants were mothers or teachers: for example, teachers were more likely to report a high Total Difficulties score for Black Caribbean and Black African children than were their mothers, while for Pakistani and Bangladeshi children it was the other way around.

Table 7-1 Descriptive statistics – Percentage of children with clinically relevant socio-emotional difficulties at age seven, by child and family characteristics

	Mother-reported difficulties (max. N= 12,766)		**Teacher-reported difficulties (max. N= 8,382)**	
	% of N	% with difficulties	% of N	% with difficulties
All	100	9.9	100	10.3
Child gender				
Boy	50.9	12.4	50.7	13.6
Girl	49.1	7.2	49.3	6.9
SEN statement				
No	91.9	7.6	91.9	7.9
Yes	8.2	33.0	8.1	35.3
Income quintile				
Top	19.8	3.8	21.2	6.7
Fourth	19.9	5.7	21.2	7.1
Third	20.6	8.7	20.9	9.4
Second	20.3	14.1	18.9	12.5
Bottom	19.5	17.7	17.8	17.5
NS-SEC (combined)				
Managerial / professional	40.8	4.6	42.8	6.3
Intermediate	11.1	7.3	11.3	7.4
Small empl. / self empl.	8.8	6.8	9.3	8.2
Lower supervisory / tech.	5.8	10.9	5.8	10.7
Semi routine / routine	14.1	14.0	13.2	13.5
No parent in work	19.3	20.2	17.7	19.8
Housing tenure				
Own / mortgage	67.0	5.8	68.6	6.9
Rent privately	8.6	13.2	8.7	15.3
Social housing	22.2	18.9	20.6	18.0
Other	2.2	13.6	2.1	10.9
Maternal age at interview				
40 plus	29.0	5.8	29.9	7.4
30 – 39	54.2	8.9	54.6	9.5
20 – 29	16.9	18.8	15.5	17.6

	Mother-reported difficulties (max. N= 12,766)		**Teacher-reported difficulties (max. N= 8,382)**	
	% of N	% with difficulties	% of N	% with difficulties
Maternal NVQ level				
Level 4/5	37.4	5.0	39.6	7.0
Level 3	15.4	9.1	15.4	10.3
Level 2	26.5	10.2	26.6	10.2
Level 1	6.9	17.0	6.7	15.9
Overseas only	2.8	12.8	2.5	16.5
None	11.1	21.1	9.3	17.7
Child ethnicity				
White	86.0	9.6	87.6	10.1
Mixed	2.7	11.6	2.4	13.6
Indian	2.3	9.2	2.1	8.4
Pakistani	3.6	14.9	3.2	10.7
Bangladeshi	1.2	8.9	0.9	6.4
Black Caribbean	1.1	13.6	0.9	23.9
Black African	1.6	6.2	1.5	12.6
Other (incl. Chinese)	1.4	11.3	1.3	11.3
Moved before sweep 3				
No	51.1	7.8	50.5	8.3
Yes	48.9	11.8	49.5	12.3
Friends in the area				
Has friends in the area	89.2	9.1	89.7	9.5
No friends but family	5.5	13.7	5.1	13.9
Neither friends nor family	5.3	20.1	5.1	21.2
Parks/playgrounds in the area				
Yes	89.0	9.5	89.1	10.1
No	11.0	13.0	10.9	13.1

7.2.2 Neighbourhood characteristics and socio-emotional development

This section describes associations between children's socio-emotional development and the following neighbourhood measures: the Index of Multiple Deprivation (IMD), neighbourhood median household income, the percentage of social housing in the neighbourhood, maternal neighbourhood satisfaction and interviewer observations of neighbourhood disorder.

As has been shown in chapter four, the IMD was highly correlated with the percentage of social housing (r= -0.73) and with median neighbourhood income (r= 0.65), while the correlation between median neighbourhood income and the proportion of social housing was -0.54.

Maternal neighbourhood perceptions and interviewer observations[1] might capture aspects of the neighbourhood social environment that census-derived measures of neighbourhood composition can not, and have already been shown in the previous chapter to be associated with levels of maternal psychological distress. Both measures stemmed from sweep two of the study and were used to look at the associations between neighbourhood characteristics and children's socio-emotional outcomes over time.

Table 7-2 presents the bivariate associations between these measures (divided into weighted quintiles) and the percentage of children with socio-emotional difficulties as reported by the mother and the teacher. The gradients were very similar across the three measures of structural and compositional neighbourhood characteristics, as was expected given the correlations between them. Children were more likely to display socio-emotional difficulties if they were living in more deprived neighbourhoods, neighbourhoods where the median income was lower and neighbourhoods with a higher proportion of households living in social housing. Similarly, there were linear associations between both mother's and interviewer's appraisals of the neighbourhood (reported when the children were about three years old), and children's socio-emotional difficulties at age seven. The association with maternal neighbourhood perceptions appeared to be somewhat less strong for the teacher-reported outcome than for the mother-reported outcome.

[1] Mothers' ratings included overall satisfaction with the area, whether the area was good to bring up children and feelings of safety. Interviewers rated aspects of the neighbourhood such as litter and graffiti, run-down buildings as well as how safe and comfortable they felt in the street.

Table 7-2 Descriptive statistics – Percentage of children with clinically relevant socio-emotional difficulties at age seven, by neighbourhood characteristics in quintiles

Quintiles	Children with socio-emotional difficulties (%)	
	Mother reported (max. N= 12,765)	Teacher reported (max. N= 8,382)
IMD		
Most deprived	16.6	15.7
Second	12.0	12.4
Third	7.6	7.7
Fourth	8.7	9.9
Least deprived	4.3	6.6
Neighbourhood median household income		
Lowest	15.3	14.7
Second	12.8	11.6
Third	9.3	8.9
Fourth	6.6	9.0
Highest	5.5	7.9
Percentage living in social housing		
Lowest	4.5	6.2
Second	6.9	7.6
Third	9.3	10.7
Fourth	12.2	12.3
Highest	16.7	15.8
Maternal neighbourhood satisfaction, sweep 2		
Most satisfied	5.0	7.4
Second	7.9	8.1
Third	8.4	10.7
Fourth	10.6	10.2
Least satisfied	16.1	13.8
Observed neighbourhood disorder, sweep 2		
Most favourable	4.1	5.7
Second	5.1	7.7
Third	8.0	8.1
Fourth	12.3	11.4
Least favourable	17.0	16.3

7.2.3 Maternal psychological distress, parenting and children's socio-emotional development

The Kessler-6 scale at sweep four was used in the bivariate analyses as a categorical variable. The cut-offs were 0-3 for no distress, 4-12 for moderate distress and 13 or over for severe distress (Calderwood et al., 2007). To look at associations with chronic maternal distress, a variable was constructed to indicate whether the mother experienced any distress (had a score of more than 3) either never, in the past only (at sweep two and/or sweep three), concurrently (at sweep four only, or at sweep four and one earlier sweep), or persistently (at sweeps two, three and four). While less than 4% of all mothers reported the experience of severe distress at sweep four, chronic distress was fairly common - more than 13% of all mothers reported symptoms of at least moderate distress at three consecutive sweeps.

The bivariate relationships between maternal levels of distress and children's socio-emotional difficulties are shown in Table 7-3. There appear to be strong associations between maternal levels of distress, both cross-sectionally and over time, and mothers' reporting of socio-emotional difficulties in the child, a relationship that is likely to be bidirectional. Of the mothers who reported moderate levels of distress at sweep four, about 17% also reported a high score for their children's total socio-emotional difficulties. Among mothers who persistently experienced distress this was 23%. There were clear correlations also with teacher-reported scores, however these associations appeared to be less steep.

The parenting practices considered were the same as in the previous chapter, with the exception of daily shouting, and were dichotomised in the same way. Table 7-4 presents the bivariate associations between socio-emotional difficulties and aspects of parenting (measured at sweep four). Children were more likely to be identified as having socio-emotional difficulties when they were not read to daily or almost daily, when they had no regular bedtime and when the mother reported the use of smacking as a parenting strategy.

Table 7-3 Descriptive statistics – Percentage of children with clinically relevant socio-emotional difficulties at age seven, by maternal psychological distress

	% of N	% with mother reported difficulties (max. N= 12,487)	% of N	% with teacher reported difficulties (max. N= 8,128)
Maternal distress sweep 4 (child aged 7)				
None	68.2	4.9	69.6	7.7
Moderate	28.2	17.1	27.0	14.7
Severe	3.7	39.9	3.5	26.4
Maternal distress over time (child aged 3-7)[1]				
Never	48.7	2.9	50.0	6.0
Past only	20.2	8.0	20.2	11.1
Concurrent	17.4	14.9	16.9	14.2
Persistent	13.7	23.3	12.9	15.8

Table 7-4 Descriptive statistics – Percentage of children with clinically relevant socio-emotional difficulties at age seven, by parenting behaviours (all measures from sweep four)

	% of N	% with mother reported difficulties (max. N= 12,764)	% of N	% with teacher reported difficulties (max. N= 8,142)
Reading				
Read to daily / almost daily	41.9	8.0	42.2	9.7
Less than daily	58.1	11.2	57.8	10.8
Regular bedtime				
Always/usually regular bedtime	90.7	9.3	90.9	9.9
No regular bedtime	9.3	15.9	9.1	15.3
Smacking				
Never smacked	52.2	8.0	52.6	8.9
Smacking used at all	47.9	11.7	47.4	11.8

[1] "Maternal distress" includes all mothers with a score higher than 3 on the Kessler-6 scale.

7.3 Cross-classified multilevel models - cross-sectional analysis

The objectives of this section were to assess the relative importance of neighbourhoods and schools for children's socio-emotional development, and to test whether and how much the available contextual measures contributed towards explaining the variability in children's socio-emotional difficulties across neighbourhoods and schools. Further, it was tested whether maternal psychological distress and parenting practices were on the pathway between neighbourhood characteristics and the socio-emotional outcomes.

7.3.1 Analytical strategy

This was a cross-sectional analysis with all measures stemming from sweep four of the study. However, information from earlier sweeps was utilised to determine whether and when children had moved or changed schools. Only children who had lived in the same neighbourhood and had not changed schools at least since sweep three (age five), were included in the analysis[1].

Following these exclusions, the analysis sample for mother-reported socio-emotional difficulties comprised 9,840 children with complete information on the outcome, exposure variables and covariates, while for teacher-reported difficulties the sample size was 6,450. A table comparing the characteristics of the two analysis samples can be found in Appendix V (Table 11-9). In both analysis samples, the mean age of all children was 7 years and 3 months, and 50.9% were boys. As was the case for the descriptive statistics (which used all available information), the teacher report subsample was slightly more advantaged compared to the mother report sample.

To determine the variability in children's socio-emotional difficulties across neighbourhoods and schools, cross-classified multilevel models were run using the Markov Chain Monte Carlo (MCMC) estimation method[2]. For both mother and teacher reports, the following series of models was estimated:

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[1] For families who did not participate at sweep three, children were included if the LSOA at sweep two (or sweep one if information at sweep two was also missing) was the same as the LSOA at sweep four (this means that children who had moved within the same neighbourhood were kept in the sample). Mothers were asked at sweep four whether the child had changed schools since the last interview, and children were excluded if the mother had answered "Yes".

[2] A short overview of MCMC estimation has been given in chapter five (section 5.2.6). Models were run with a burn-in period of 1,500 and a chain length of 50,000 iterations.

1. Variance components models

The first model was the empty two-level model with neighbourhoods as the higher level, run without any explanatory variables. Next, an empty cross-classified model was estimated, showing the effect of additionally taking schools into account. The cross-classified model provided estimates of the total variance in the outcome between neighbourhoods, schools and children/families, thus addressing the first objective of this chapter. For the teacher-reported scores, teachers were treated as an additional (fourth) level. This was done because the data was sparse and for about 77% of schools in the analysis sample there was only one teacher doing the rating, therefore differences between schools might have reflected what were actually differences between teachers[1].

2. Adjusting for family-level covariates only

Then, a model was estimated that adjusted for the battery of individual level covariates, to see how much of the overall variance was explained by what can be thought of as neighbourhood composition. The following covariates were included: child gender, child age in months, whether the child had special educational needs (SEN status), weekly family income (scaled so that 1 unit represented £100), NS-SEC (of either mother or father, whichever was higher), housing tenure, mother's age in years, maternal education (NVQ level), number of siblings in the household, family structure, child ethnicity and whether the family had moved prior to sweep three. This and the following models also adjusted for the MCS design strata, as discussed in the previous chapters.

3. Adjusting for family-level covariates and neighbourhood characteristics

The next model included both family-level covariates and contextual measures. This allowed an assessment of whether neighbourhood and school factors were independently associated with the outcome and whether these variables contributed additionally to the variability between neighbourhoods and schools (objective number two of this chapter). Although not strictly a neighbourhood-level variable, having neither friends nor family in the area was also included in this model, because it might be a factor signalling isolation or a lack of belonging to the neighbourhood. The neighbourhood-level variables used were median household income (scaled so that 1 unit represented £1,000), percentage of households living in social housing (as per 2001 census, and scaled so that 1 unit represented 10%), a rural/urban indicator and the (mother-reported) availability of parks or

[1] About 30% of teachers reported on more than one child.

playgrounds. The Index of Multiple Deprivation was not used because of its high correlation with the other two variables and because initial analyses showed that the IMD was no longer significantly associated with the outcomes after median neighbourhood income and proportion of social housing were introduced to the model. The two measures of neighbourhood composition were aggregated at LSOA level. The only measure available at school level was whether school fees were applicable.

4. Testing the role of maternal psychological distress and parenting behaviours

Relating to objective number three, the role of maternal psychological distress and parenting was assessed under the following assumptions. If maternal distress or parenting behaviours were on the pathway between neighbourhood characteristics and socio-emotional development, adding these measures to the previous model should result in a reduction of the coefficients for the neighbourhood or school characteristics (consistent with mediation) [1]. Or, if there was still statistically significant variation between neighbourhoods, a drop in this unexplained neighbourhood level variance would suggest that maternal levels of distress (or parenting) were associated with unknown neighbourhood factors.

The measure of maternal psychological distress was the Kessler-6 score as a continuous variable. The parenting behaviours considered were whether the mother read to the child daily, whether the child had a regular bedtime and whether the mother reported the use of smacking.

For each model, the total unexplained variance was estimated as well as the VPC for neighbourhoods and schools (and teachers for the teacher-reported outcome). Also calculated were the percentages of the total neighbourhood, school and teacher variance that the model was able to explain. The Bayesian DIC was used as a measure of model fit. The smaller the statistic, the better the model fit, whereby a reduction of 5-10 points is considered indicative of a statistically significant difference (Leckie, 2009). Statistical significance of the random effects was determined by comparing the DIC statistic against a model without the random effect in question.

5. Testing for cross-level interactions and complex variation

Associations with neighbourhood factors might depend on characteristics of the child or family. Such interaction effects can exist also when the association with the variable in

[1] The issues regarding the testing of mediation have been discussed in more detail in chapter five (section 5.2.9).

question is not statistically significant for the sample as a whole. The fourth objective of this chapter was to test whether there were interactions with neighbourhood median household income or the percentage of social housing by child gender and family relative poverty. Relative poverty was defined as living on an income below 60% of the median of the population. Further, it was tested whether there were differences in the variability in the outcome (at both neighbourhood and individual levels) by gender or by family relative poverty status. These analyses were carried out separately on two-level models using Stata's -xtmixed- command[1].

7.3.2 Socio-emotional difficulties as reported by the mother

The analysis sample consisted of 9,840 children. Table 7-5 shows the number of neighbourhoods and schools that were analysed as well as the number of observations per group.

Table 7-5 Number of LSOA's and schools / observations per group, mother report analysis sample (N = 9,840)

Groups	Number of groups	Observations per group		
		Min	Average	Max
LSOA's	4,374	1	2.2	32
Schools	3,882	1	2.5	26

Table 7-6 presents the estimates for the variance components models. According to Model A, the two-level empty model, 6.9% of the overall variance in mother-reported socio-emotional difficulties was due to differences between neighbourhoods. Introducing a random effect for schools in a cross-classified model (Model B) markedly improved the model fit and revealed that the variance attributable to contextual factors was actually larger, with neighbourhoods and schools together accounting for 9.9% of the overall variability in the outcome. Of that, 4.4% were due to differences between neighbourhoods and 5.5% were due to differences between schools.

[1] The meanings of cross-level interactions and complex variation have been described in chapter five (section 5.2.8).

Table 7-6 Variability in total socio-emotional difficulties as reported by the mother – comparison of two-level and three-level cross-classified variance components models (MCMC estimation, N = 9,840)

	Estimate (Standard Deviation)	
	Two-level model (A)	**Three-level cross-classified model (B)**
Constant	7.25 (0.06)	7.26 (0.06)
Neighbourhood variance	1.93 (0.29)	1.24 (0.30)
School variance	–	1.54 (0.31)
Residual variance	26.00 (0.44)	25.16 (0.46)
Total variance	27.93	27.95
% of total variance due to neighbourhoods	**6.9**	**4.4**
% of total variance due to schools	–	**5.5**
Bayesian DIC (smaller is better)	60,548	60,470

Model C in Table 7-7 adjusted for the MCS stratum variable and for child and family covariates. Girls scored on average 1 point lower on the Total Difficulties scale and children with SEN statement scored on average 5 points higher. Older children tended to have lower scores. Of the family characteristics, lower family income, low social class and a lower level of maternal education were associated with higher average scores. Living in social housing was also independently associated with more socio-emotional difficulties: children living in social housing scored on average 0.9 points higher compared to children whose families lived in owned or mortgaged accommodation. Average scores were also slightly increased for children whose families had not been residentially stable before sweep three. In terms of ethnicity, Pakistani mothers reported on average slightly higher scores while Black African mothers reported markedly lower scores. The child and family characteristics included in this model fully explained the neighbourhood and school variability in the outcome: neither the random school effect nor the random neighbourhood effect was statistically significant in this model.

Adding the contextual level variables (Model D) showed that a higher percentage of social housing in the neighbourhood was associated with on average more socio-emotional difficulties, however the size of the association was small. A 10% increase in the proportion of residents living in social housing was associated with an average increase in Total Difficulties of about 0.1 points, after allowing for family level background characteristics. Neighbourhood median household income was not independently associated with children's socio-emotional difficulties, and there was also no statistically significant difference between urban and rural settings or between fee-paying and non-fee-paying schools. There was a weak but statistically significant relationship with the availability of parks and playgrounds: Children living in neighbourhoods where no such spaces were available scored on average 0.3 points higher on the Total Difficulties scale. Children whose mothers reported to have neither friends nor family in the area scored on average 1.1 points higher compared to those whose families were locally connected.

The association with living in social housing was attenuated, suggesting that the negative influence of social housing was partly due to these contextual factors. Otherwise, the addition of the neighbourhood variables did not lead to important changes in the remaining covariates.

In this model, the between-school variability was marginally statistically significant (DIC for a model without the random school effect = 58,657, compared to 58,649 for Model D).

7.3.2.1 Testing the role of maternal psychological distress

As expected, there were strong associations between levels of mother's psychological distress and their reports of children's socio-emotional difficulties (Model E in Table 7-7), which was also reflected in the much improved model fit and sizable reduction of the unexplained individual level variance. After adjusting for family and child characteristics, a 1-point increase in the Kessler-6 score was associated with an average 0.4 point increase in the Total Difficulties score.

The relationship with housing tenure was again attenuated. Living in social housing possibly influences children's socio-emotional development in part via associations with maternal psychological distress. A marked change occurred also in the coefficient for weekly family income – an indication that maternal distress is likely to be on the pathway between material disadvantage and mother's perceptions of their children's socio-emotional difficulties. Also reduced was the coefficient for having no social connections within the area – it appears that this factor was associated with higher levels of distress. The absence of parks and playgrounds was no longer a statistically significant factor, however the coefficient had been small also in Model D. The association with the percentage of families living in social housing in the neighbourhood was only slightly attenuated.

Given that the neighbourhood characteristics included in Model D did not make strong contributions to the variability in children's socio-emotional difficulties across neighbourhoods (with the exception of having no friends and family in the area, which was however rare and for which reverse causality cannot be ruled out), it must be concluded that there is no convincing evidence to support the hypothesis of a mediating role of maternal psychological distress in the relationship between neighbourhood characteristics and children's socio-emotional difficulties.

7.3.2.2 Testing the role of parenting practices

An additional model was estimated comprising the variables included in Model E, plus the three parenting practices (daily reading, regular bedtime and smacking). Daily reading was not at all related to mother-reported socio-emotional difficulties net of the family and neighbourhood characteristics included in the model. The other two parenting behaviours were strongly associated with the outcome: independent of the family background characteristics, children who had no regular bedtime scored on average 1 point higher, and children whose mothers reported the use of smacking scored on average 1.3 points higher compared to their counterparts. However there was no indication that these parenting behaviours were on the pathway between any of the neighbourhood factors and children's socio-emotional difficulties (data shown in Appendix VI, Table 11-10, Model F).

Table 7-7 Results of cross-classified multilevel models predicting total socio-emotional difficulties, as reported by the mother (N = 9,840)

	Estimate (Standard Deviation)		
	Model C	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	0.27 (0.14)*	0.08 (0.15)	0.10 (0.14)
England – ethnic	0.44 (0.25)*	0.24 (0.25)	0.34 (0.24)
Wales – advantaged	-0.44 (0.24)*	-0.50 (0.24)*	-0.43 (0.23)*
Wales – disadvantaged	-0.04 (0.18)	-0.21 (0.20)	-0.19 (0.18)
Scotland – advantaged	-0.49 (0.21)*	-0.65 (0.24)**	-0.51 (0.22)*
Scotland – disadvantaged	-0.02 (0.22)	-0.37 (0.25)	-0.29 (0.23)
NI – advantaged	-0.60 (0.26)**	-0.82 (0.28)**	-0.60 (0.27)*
NI – disadvantaged	-0.19 (0.22)	-0.54 (0.26)*	-0.32 (0.24)
Child and family level			
Girl	-1.03 (0.10)***	-1.02 (0.10)***	-0.97 (0.09)***
Child age in months	-0.05 (0.02)**	-0.05 (0.02)**	-0.05 (0.02)**
Has SEN statement	4.95 (0.18)***	4.93 (0.18)***	4.62 (0.18)***
Weekly family income per £100	-0.18 (0.03)***	-0.16 (0.03)***	-0.10 (0.03)***
NS-SEC (ref= manag. / prof.)			
Intermediate	0.13 (0.17)	0.10 (0.17)	0.11 (0.16)
Small empl. / self empl.	0.26 (0.19)	0.26 (0.19)	0.33 (0.18)*
Lower supervisory / tech.	0.24 (0.22)	0.18 (0.22)	0.19 (0.22)
Semi routine / routine	0.83 (0.17)***	0.76 (0.17)***	0.74 (0.16)***
No parent in work	0.91 (0.19)***	0.88 (0.19)***	0.53 (0.18)**
Housing tenure (ref= owner)			
Rented privately	0.28 (0.23)	0.26 (0.23)	0.16 (0.22)
Social housing	0.92 (0.16)***	0.72 (0.17)***	0.56 (0.16)***
Other	0.34 (0.36)	0.30 (0.37)	0.24 (0.34)
Maternal age (years)	-0.06 (0.01)***	-0.06 (0.01)***	-0.07 (0.01)***
Maternal NVQ (ref = level 4/5)			
Level 3	0.15 (0.15)	0.11 (0.15)	0.12 (0.14)
Level 2	0.42 (0.13)**	0.39 (0.13)**	0.36 (0.13)**
Level 1	0.83 (0.21)***	0.80 (0.21)***	0.81 (0.21)***
Overseas only	1.42 (0.35)***	1.36 (0.35)***	1.19 (0.34)***
None	1.60 (0.20)***	1.54 (0.21)***	1.32 (0.20)***
Number of siblings (ref = none)	-0.18 (0.05)***	-0.18 (0.05)***	-0.18 (0.05)***

Table 7-7 (continued)

	Estimate (Standard Deviation)		
	Model C	**Model D**	**Model E**
Family structure (ref = both natural parents)			
Natural mother / other partner	1.14 (0.23)***	1.15 (0.23)***	0.96 (0.22)***
Single mother	0.27 (0.15)*	0.29 (0.15)*	0.11 (0.14)
Child ethnicity (ref = White)			
Mixed	0.13 (0.33)	0.11 (0.33)	-0.04 (0.31)
Indian	0.33 (0.37)	0.39 (0.37)	0.24 (0.35)
Pakistani	1.02 (0.34)**	1.02 (0.34)**	0.78 (0.32)**
Bangladeshi	0.97 (0.52)*	0.91 (0.52)*	0.92 (0.50)*
Black Caribbean	0.10 (0.48)	0.05 (0.48)	-0.10 (0.46)
Black African	-1.83 (0.44)***	-1.99 (0.45)***	-1.76 (0.43)***
Other (incl. Chinese)	0.75 (0.46)	0.78 (0.46)*	0.36 (0.44)
Moved before sweep three	0.18 (0.10)*	0.21 (0.10)*	0.10 (0.10)
Neither friends nor family in the area		1.11 (0.26)***	0.76 (0.25)**
Neighbourhood level			
Rural (ref = urban)		-0.03 (0.12)	-0.01 (0.12)
Median household income, per £1000		-0.01 (0.01)	-0.01 (0.01)
% Social housing, per 10%		0.09 (0.04)**	0.07 (0.03)*
No park/playground in the area		0.34 (0.16)*	0.24 (0.15)
School level			
Fees applicable		-0.29 (0.32)	-0.35 (0.30)
Maternal distress (Kessler-6, continuous)			0.39 (0.01)***
Constant	13.83 (1.51)	13.52 (1.55)	12.81 (1.47)
Neighbourhood variance	0.19 (0.15)^{NS}	0.07 (0.11)^{NS}	0.12 (0.13)^{NS}
% of total neighbourhood variance explained	84.7	94.4	90.3
School variance	0.07 (0.13)^{NS}	0.30 (0.17)	0.04 (0.08)^{NS}
% of total school variance explained	95.5	80.5	97.4
Residual variance	22.30 (0.41)	22.26 (0.36)	20.47 (0.32)
Total unexplained variance	22.56	22.63	20.63
% of unexplained variance due to neighbourhoods	0.8	0.3	0.6
% of unexplained variance due to schools	0.3	1.3	0.2
Bayesian DIC (smaller is better)	58,683	58,649	57,752

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ ^{NS} Random effect not statistically significant

7.3.2.3 Testing for cross-level interactions and complex variation

There were no statistically significant interactions by child gender, and also none between the percentage of social housing in the neighbourhood and the family's relative poverty status (results not shown).

However, an interaction was present between family relative poverty status and neighbourhood median household income. The model in table 7-8 (Model G) is a two-level model that adjusted for the same covariates as Model E in Table 7-7, with the addition of an indicator variable for family relative poverty and the interaction term. This model also allowed the between-neighbourhood variance and the within-neighbourhood variance to vary by relative poverty status (complex level-2 and complex level-1 variation), estimating these parameters separately for poor and non-poor children. The log-likelihood statistic was used to compare this model against a model with no complex variation, showing that the model fit was significantly improved when the complex variation was estimated (log likelihood for the model without complex variation = -28,827.4, p-value LR test < 0.001). A model which only estimated complex variation at level 1 (the individual level) was also a worse fit compared to the model with complex variation at both levels (log-likelihood = -28,763.3, LR test p-value <0.05).

Table 7-8 shows the coefficients for the relevant main effects and the interaction term. It can be seen that the main effect for median neighbourhood income was not statistically significant, meaning that median neighbourhood income was not independently associated with mother-reported socio-emotional difficulties for children not living in relative poverty.

For children from poor families, while their average scores were generally higher, the Total Difficulties score decreased on average by 0.03 points for every £1000 increase in median neighbourhood income, an effect size that is however small. More interestingly, the table shows that there was much more variability in Total Difficulties scores among poor children at both the neighbourhood and the individual level than among children not living in relative poverty. While the between-neighbourhood variance for children not living in poverty was close to zero, there was sizable variability across neighbourhoods for poor children even after allowing for the family and contextual covariates that were included in the model, with about 5% of the overall variance in the outcome due to differences between neighbourhoods.

Table 7-8 Model G - two-level model predicting mother-reported socio-emotional difficulties, allowing for complex variation at level 1 and level 2, adjusted for the same covariates and contextual variables included in Model E plus relative poverty indicator and interaction term (N = 9,840)

	Estimate (Standard Error)	
	Non poor	**Poor**
Poor (income < 60% median)		0.86 (0.37)*
Median neighbourhood income, per £1000	-0.00 (0.01)	-0.00 (0.01)
Interaction term "median neighbourhood income x poor"		-0.03 (0.02)*
Neighbourhood variance	0.11 (0.20)	1.35 (0.65)
Residual (within-neighbourhood) variance	18.32 (0.36)	25.02 (0.92)
Total variance	18.43	26.37
VPC	0.6	5.1
Log likelihood		-28,761.0

* p < 0.05

7.3.3 Socio-emotional difficulties as reported by the teacher

As mentioned above, for teacher-reported scores the teachers were treated as an additional level. The number of groups included in the sample and average observations per group are shown in Table 7-9.

Table 7-9 Number of LSOA's and schools / observations per group, teacher-report subsample (N = 6,450)

Groups	Number of groups	Observations per group		
		Min	Average	Max
LSOA's	3,434	1	1.9	25
Schools	2,957	1	2.2	20
Teachers	3,939	1	1.6	12

Five empty models were estimated which are presented in Table 7-10.

The first empty model was the two-level model with neighbourhoods as the higher level (Model A). Model B was a three-level cross-classified model with neighbourhoods and schools as the higher levels. Model C was a three-level cross-classified model with neighbourhoods and teachers as the higher levels. Model D was again a three-level cross-classified model with schools and teachers as the higher levels. Model E was a four-level model that included random effects for neighbourhoods, schools and teachers. As before, the three-level model (B) was a much better fit than the two-level model (A). The DIC decreased again greatly when instead of schools, teachers were treated as the higher level (Model C), indicating that indeed the differences between schools in Model B were mainly due to variability between teachers. The three-level model (D) was a worse fit compared to Model C. There was no statistically significant difference in model fit between Model C and the four-level-model (E), however it was decided to proceed with Model E, as it was deemed unlikely that the true variability between schools was equal to zero. According to this model, 2.8% of the overall variability in teacher-reported socio-emotional difficulties was between neighbourhoods, 3.1% was between schools and as much as 13.2% was due to differences between the teachers themselves.

The issue of between-rater variance is an important and interesting one but was beyond the scope of this project and not investigated in further detail. However, the teacher random effect was still estimated in the following models, because ignoring this large variability would have led to a distortion of the neighbourhood and school variance.

Table 7-10 Variability in total socio-emotional difficulties as reported by the teacher – comparison of different variance components models (MCMC estimation, N = 6,450)

	Estimate (Standard Deviation)				
	Two-level model (A)	**Three-level cross-classified model (B)**	**Three-level cross-classified model (C)**	**Three-level cross-classified model (D)**	**Four-level cross-classified model (E)**
Constant	5.99 (0.07)	6.05 (0.08)	6.03 (0.08)	6.05 (0.08)	6.04 (0.08)
Neighbourhood variance	2.37 (0.49)	0.81 (0.49)	1.08 (0.47)	–	0.87 (0.48)
School variance	–	3.17 (0.48)	–	1.32 (0.54)	0.96 (0.61)
Teacher variance	–	–	4.89 (0.59)	3.99 (0.75)	4.04 (0.78)
Residual variance	28.22 (0.65)	26.63 (0.66)	24.62 (0.68)	25.30 (0.64)	24.73 (0.69)
Total variance	30.59	30.61	30.59	30.61	30.60
% of total variance due to neighbourhoods	**7.7**	**2.6**	**3.5**	**–**	**2.8**
% of total variance due to schools	**–**	**10.4**	**–**	**4.3**	**3.1**
% of total variance due to teachers	**–**	**–**	**16.0**	**13.0**	**13.2**
Bayesian DIC (smaller is better)	40,280	40,148	40,030	40,060	40,032

Model F in Table 7-11 shows the relationships with the child and family characteristics. Again, girls had on average lower scores than boys and children with an SEN statement scored much higher than children without SEN. Interestingly, family income was not independently associated with teacher-reported socio-emotional difficulties, however social class was. Children living in families where no parent was in work scored on average 1 point higher than children from households where at least one parent belonged to the managerial/professional group. Similar to what was found for mother-reported difficulties, children living in social housing scored about 0.7 points higher than children living in owned or mortgaged accommodation. Renting privately was associated with an average increase in the score of 0.6 points. Regarding maternal education, only children whose mothers had no qualifications had significantly higher scores (on average 1.2 points higher) compared to children whose mothers were educated up to university level. Indian and Bangladeshi children scored markedly lower than White children on the teacher-reported difficulties scale. Contrary to the results for the mother-reported outcome, there were no associations with maternal age and having moved before age five.

Similar to the mother-reported outcome, adjusting for the child and family covariates explained both the between-neighbourhood and the between-school variance (DIC without random effects for neighbourhoods and schools = 39,073). Of the relatively large between-teacher variance, only about 21% was explained by what can be thought of as classroom composition or school intake.

Model G then included the contextual variables. Having no friends or family in the area was associated also with increased teacher-reported socio-emotional difficulties (about 1.4 points). Of the neighbourhood-level factors, only the proportion of social housing in the neighbourhood was associated with the outcome after allowing for family background variables. The relationship was positive but of moderate size: for every 10% increase in the proportion of social housing in the neighbourhood, the average Total Difficulties score increased by 0.1 points. Taking neighbourhood-level social housing into account however attenuated the association with living in social housing. Neighbourhood median household income and the rural/urban indicator were not independently associated with teacher-reported scores. Teachers in fee-paying schools reported on average worse behaviour for their pupils than teachers in non-fee paying schools.

Again, there was no statistically significant difference in model fit when the random neighbourhood and school effects were omitted.

7.3.3.1 Testing the role of maternal psychological distress

Maternal psychological distress had much less explanatory power for teacher-reported socio-emotional difficulties, compared to what has been shown for the mother reports (Model H in Table 7-11). For every point increase in the Kessler-6, the Total Difficulties score increased on average by 0.1 points. Accounting for maternal distress resulted only in a small reduction of the unexplained variability in the outcome, also reflected in the less dramatically improved model fit compared to what had been observed for the mother-reported scores.

There were almost no changes in the estimates for the neighbourhood variables, and neither were important changes found for the associations with the family-level characteristics. Testing model fit against a model without the neighbourhood and school random effects showed that neither was statistically significant (DIC for a model without both random effects = 39,006). The between-teacher variance was slightly decreased after adding maternal psychological distress to the model.

In line with the findings for mother-reported Total Difficulties, there was no support for the hypothesis of maternal psychological distress to be on the pathway between neighbourhood characteristics and teacher-reported socio-emotional difficulties in the child.

7.3.3.2 Testing the role of parenting practices

Similar to the findings for mother-reported Total Difficulties, children with no regular bedtime and children exposed to smacking had on average higher scores, while children who were not read to daily had on average slightly *lower* scores. As before, including the parenting variables in the model did not lead to changes in any of the coefficients for the neighbourhood-level variables (data shown in Appendix VI, Table 11-11, Model I). The results provided therefore no evidence to support the hypothesis that parenting practices mediated relationships between the examined neighbourhood characteristics and teacher-reported socio-emotional difficulties.

Table 7-11 Results of cross-classified multilevel models predicting total socio-emotional difficulties, as reported by the teacher (N = 6,450)

	Estimate (Standard Deviation)		
	Model F	**Model G**	**Model H**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	0.42 (0.20)*	0.25 (0.21)	0.24 (0.21)
England – ethnic	0.72 (0.35)*	0.57 (0.35)	0.59 (0.36)
Wales – advantaged	-0.06 (0.34)	-0.11 (0.35)	-0.11 (0.35)
Wales – disadvantaged	0.25 (0.26)	0.11 (0.28)	0.10 (0.28)
Scotland – advantaged	-0.22 (0.30)	-0.35 (0.32)	-0.33 (0.32)
Scotland – disadvantaged	-0.23 (0.32)	-0.55 (0.35)	-0.56 (0.34)
NI – advantaged	-0.05 (0.33)	-0.24 (0.37)	-0.19 (0.37)
NI – disadvantaged	0.11 (0.31)	-0.25 (0.36)	-0.19 (0.36)
Child and family level			
Girl	-1.61 (0.13)***	-1.61 (0.13)***	-1.62 (0.13)***
Child age in months	-0.10 (0.02)***	-0.10 (0.02)***	-0.10 (0.02)***
Has SEN statement	5.31 (0.24)***	5.26 (0.24)***	5.16 (0.24)***
Weekly family income per £100	-0.04 (0.04)	-0.04 (0.04)	-0.02 (0.04)
NS-SEC (ref= manag. / prof.)			
Intermediate	0.24 (0.22)	0.23 (0.21)	0.23 (0.21)
Small empl. / self empl.	0.73 (0.24)**	0.70 (0.24)**	0.72 (0.24)**
Lower supervisory / tech.	0.55 (0.29)*	0.49 (0.29)*	0.50 (0.29)*
Semi routine / routine	0.94 (0.23)***	0.86 (0.23)***	0.85 (0.23)***
No parent in work	1.05 (0.25)***	0.98 (0.25)***	0.87 (0.25)***
Housing tenure (ref= owner)			
Rented privately	0.55 (0.29)*	0.51 (0.29)*	0.50 (0.29)*
Social housing	0.74 (0.21)***	0.52 (0.23)*	0.49 (0.23)*
Other	-0.19 (0.47)	-0.26 (0.47)	-0.24 (0.47)
Maternal age (years)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Maternal NVQ (ref = level 4/5)			
Level 3	-0.01 (0.20)	-0.04 (0.19)	-0.04 (0.19)
Level 2	0.05 (0.17)	0.03 (0.17)	0.03 (0.17)
Level 1	0.29 (0.28)	0.28 (0.28)	0.28 (0.28)
Overseas only	-0.08 (0.48)	-0.12 (0.48)	-0.16 (0.47)
None	1.19 (0.27)***	1.14 (0.27)***	1.09 (0.27)***
Number of siblings (ref = none)	-0.26 (0.07)***	-0.27 (0.07)***	-0.27 (0.07)***

Table 7-11 (continued)

	Estimate (Standard Deviation)		
	Model F	**Model G**	**Model H**
Family structure (ref = both natural parents)			
Natural mother / other partner	1.55 (0.30)***	1.54 (0.30)***	1.47 (0.30)***
Single mother	0.88 (0.20)***	0.87 (0.20)***	0.82 (0.20)***
Child ethnicity (ref = White)			
Mixed	-0.07 (0.45)	-0.09 (0.44)	-0.14 (0.44)
Indian	-0.74 (0.50)	-0.81 (0.50)	-0.91 (0.50)*
Pakistani	0.49 (0.49)	0.43 (0.49)	0.33 (0.49)
Bangladeshi	-2.05 (0.86)**	-2.14 (0.87)**	-2.15 (0.87)**
Black Caribbean	0.68 (0.69)	0.63 (0.69)	0.65 (0.69)
Black African	0.03 (0.64)	-0.24 (0.65)	-0.23 (0.65)
Other (incl. Chinese)	-1.63 (0.63)**	-1.62 (0.63)**	-1.74 (0.63)**
Moved before sweep three	0.12 (0.13)	0.15 (0.13)	0.11 (0.13)
Neither friends nor family in the area		1.39 (0.33)***	1.30 (0.33)***
Neighbourhood level			
Rural (ref = urban)		0.08 (0.17)	0.08 (0.17)
Median household income, per £1000		-0.01 (0.01)	-0.01 (0.01)
% Social housing, per 10%		0.11 (0.05)*	0.10 (0.05)*
No park/playground in the area		0.30 (0.21)	0.28 (0.21)
School level			
Fees applicable		1.02 (0.40)**	1.00 (0.40)**
Maternal distress (Kessler-6, continuous)			0.12 (0.02)***
Constant	15.36 (2.02)	15.02 (2.07)	14.65 (2.07)
Neighbourhood variance	0.05 (0.08)^{NS}	0.11 (0.13)^{NS}	0.09 (0.12)^{NS}
% of total neighbourhood variance explained	94.3	87.4	89.7
School variance	0.69 (0.43)^{NS}	0.53 (0.38)^{NS}	0.76 (0.42)^{NS}
% of total school variance explained	28.1	44.8	20.8
Teacher variance	3.18 (0.59)	3.30 (0.58)	2.98 (0.59)
% of total teacher variance explained	21.3	18.3	26.2
Residual variance	21.90 (0.54)	21.77 (0.55)	21.68 (0.54)
Total unexplained variance	25.82	25.71	25.51
% of unexplained variance due to neighbourhoods	0.2	0.4	0.4
% of unexplained variance due to schools	2.7	2.1	3.0
% of unexplained variance due to teachers	12.3	12.8	11.7
Bayesian DIC (smaller is better)	39,069	39,042	39,002

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ ^{NS} Random effect not statistically significant

7.3.3.3 Testing for cross-level interactions and complex variation

As before, interactions and complex variation were tested in two-level models. For the teacher-reported outcome, no interactions were found by either child gender or family relative poverty status.

Table 7-12 presents the model which tested whether an interaction between family relative poverty status and median neighbourhood income was present also for the teacher-reported scores, and which again estimated the variance components separately for poor and non-poor children (Model J). While there was no interaction, there were again marked differences between poor and non-poor children regarding the variability in the outcome, which was much larger for poor children at both neighbourhood and individual levels. This model fitted the data significantly better than a model without complex variation (log-likelihood for a model without = 19,570.8, LR test p-value<0.001). But, the complex level-2 (between-neighbourhood) variation was not statistically significant (log-likelihood for a model with complex variation only at level-1 = -19,543.0, LR test p-value= 1.00).

Table 7-12 Model J - two-level model predicting teacher-reported socio-emotional difficulties, allowing for complex variation at level 1 and level 2, adjusted for the same covariates and contextual variables included in Model H plus relative poverty indicator and interaction term (N = 6,450)

	Estimate (Standard Error)	
	Non poor	**Poor**
Poor (income < 60% median)		-0.34 (0.53)
Median neighbourhood income, per £1000	-0.01 (0.01)	-0.01 (0.01)
Interaction term “median neighbourhood income x poor”		0.02 (0.02)
Between-neighbourhood variance	0.61 (0.39)	2.64 (1.29)
Residual (within-neighbourhood) variance	22.72 (0.59)	29.05 (1.58)
Total variance	23.33	31.69
VPC	2.6	8.3
Log likelihood		-19,543.8

7.3.4 Partitioning the variance in socio-emotional difficulties between families, neighbourhoods and schools

The first objective of this chapter was the partitioning of the variance in children's socio-emotional difficulties before and after adjustment for family-level background characteristics. To visualise the variability in children's socio-emotional difficulties between neighbourhoods and schools, the decomposed variances for both mother- and teacher-reported Total Difficulties are presented as bar graphs with credibility intervals. Figure 7-2 is the decomposed variance before any adjustments. Figure 7-3 is the decomposed variance after adjustments for MCS strata and family-level factors but without taking neighbourhood and school characteristics into account, therefore it can be interpreted as an illustration of the school and neighbourhood variance that is independent of compositional effects[1].

Before any adjustments, the percentage of the overall variance that was due to differences between neighbourhoods was about 4% for mother reported scores and about 4% for teacher-reported scores. The variance due to differences between schools was about 6% for mother-reported difficulties and about 3% for the teacher-reported scores. The between-teacher variability in the rating of children's socio-emotional difficulties was rather large with 13% of the overall variance[2].

For both mother and teacher reports, once child and family characteristics were accounted for, the between-neighbourhood as well as the between-school variability were almost fully explained and no longer statistically significant (Figure 7-3). The between-rater variability in the teacher-reported scores remained large (about 12%) also after allowing for the child and family-level covariates, suggesting that these differences were due to characteristics of the raters themselves.

All variance estimates had large credibility intervals, so there was considerable variability in how much individual neighbourhoods and schools contributed to children's socio-emotional development.

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[1] The MCS strata were kept in the adjusted models because of the issue of weighting. However, the design strata contain information about neighbourhood characteristics. Therefore models were estimated also without the MCS stratum variable, adjusting only for family background. For both mother- and teacher-reported scores, the conclusions regarding the between-neighbourhood and between-school variance did not change, neither was statistically significant when family background characteristics were accounted for.

[2] To be sure that the between-teacher variability was not an artefact of the data due to sparseness, it was tested whether the mother-reported scores also varied between teachers, by estimating an empty cross-classified model that included random effects for teachers, schools and neighbourhoods. In this model, the between-teacher variance in mother-reported scores was small and only marginally statistically significant.

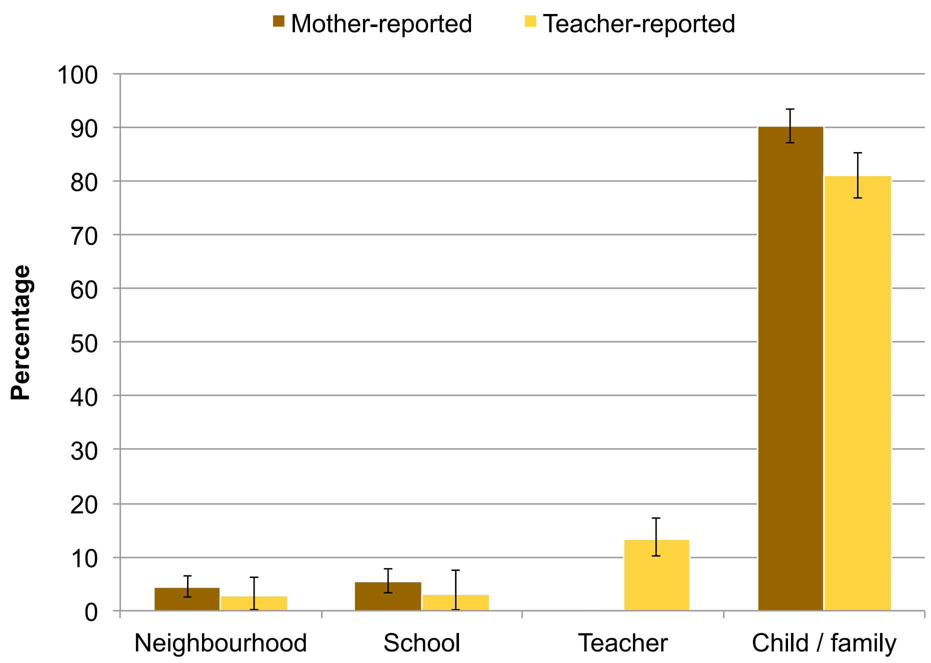

Figure 7-2 Decomposition of unadjusted variances in socio-emotional difficulties using cross-classified models, with credibility intervals

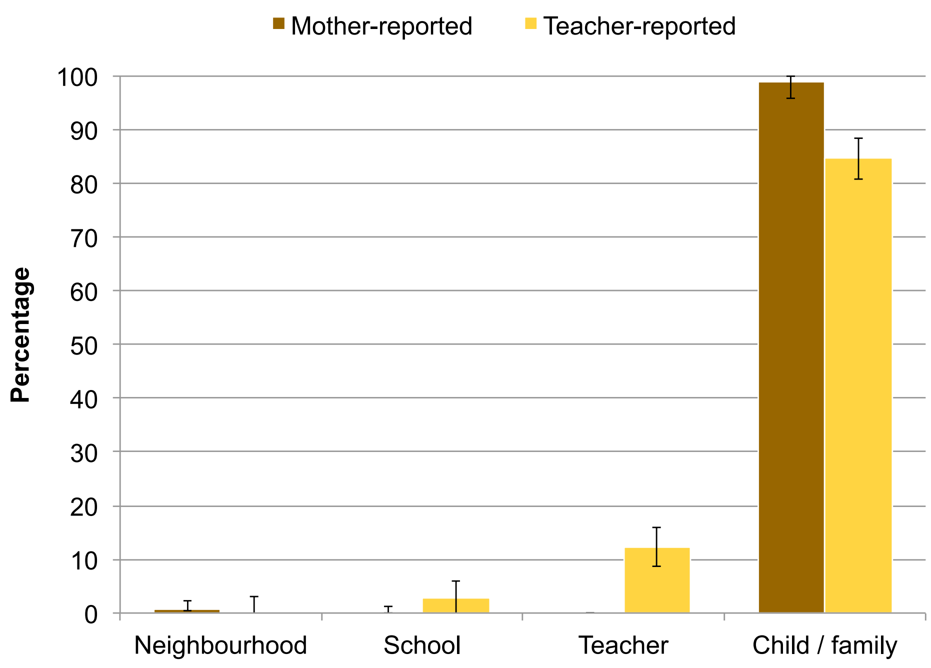

Figure 7-3 Decomposition of variances in socio-emotional difficulties using cross-classified models, after adjustment for MCS stratum and family socio-demographic background[1], with credibility intervals

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[1] Adjusted for MCS stratum, child gender, child age, SEN status, family income, NS-SEC, housing tenure, maternal age, maternal education, number of siblings, family structure, child ethnicity and whether family had moved before sweep three.

7.3.5 Summary

In this section, cross-sectional analyses were carried out to examine the variability in children's socio-emotional difficulties between neighbourhoods and schools, using the reports of mothers and teachers.

Mother-reported socio-emotional difficulties

Before any adjustments, the percentage of the overall variance in mother-reported scores that was due to differences between neighbourhoods was about 4%, while the percentage of the variance due to differences between schools was about 6%.

Family characteristics that were independently associated with higher average scores were lower family income, lower social class, the mother having no or only overseas qualifications, living in social housing and not having been residentially stable before sweep three.

After adjustment for family characteristics neither a statistically significant between-neighbourhood nor between-school variance remained. However, the percentage of social housing in the neighbourhood was significantly, if only weakly, associated with the outcome also in the fully adjusted model.

Teacher-reported socio-emotional difficulties

Compared to the mother reports, there were many similarities but also some differences regarding the family background characteristics that were associated with teacher-reported scores.

Contrary to the findings for mother-reported scores, family income was not independently associated with the outcome, and neither was residential stability before sweep three. Living in social housing was associated with higher scores also for the teacher reports, as was living in privately rented accommodation when compared to children living in owned or mortgaged housing.

The unadjusted variance in teacher-reported scores between neighbourhoods and schools was about 3% at both levels, and there was also a large between-teacher variability of about 13%. After adjusting for family background characteristics, neither neighbourhood nor school variance remained statistically significant, while the between-teacher variability was reduced only slightly. Living in neighbourhoods with a higher proportion of social housing was associated with higher scores also in the fully adjusted model.

The role of maternal psychological distress and parenting

This cross-sectional analysis produced no evidence to support the theory that maternal psychological distress or parenting behaviours were on the pathway between neighbourhood characteristics and children's socio-emotional development. Associations between the examined neighbourhood factors and either mother or teacher ratings of children's socio-emotional difficulties were weak and did not appear to be driven by neighbourhood influences on levels of maternal distress.

However, the results suggest that maternal distress was on the pathway between family income and mothers' perceptions of children's socio-emotional difficulties. Poorer mothers reported on average more difficulties for their children, an association that was attenuated when levels of maternal psychological distress were accounted for.

Maternal distress was also associated with teacher-rated socio-emotional difficulties, but the association was less strong. Mothers experiencing symptoms of distress might be more prone to perceive their children's behaviour as difficult. An alternative interpretation is that children of distressed mothers who are having difficulties at home might display fewer behavioural problems at school.

Cross-level interactions and complex variation

For mother-reported socio-emotional difficulties, a cross-level interaction was present between relative poverty at the family level and neighbourhood median household income. While neighbourhood median income was not associated with the outcome among children who were not poor, a higher median income in the neighbourhood appeared to be beneficial for children whose families were living in relative poverty, but the size of the effect was small. Further, there was more variation in the mother reported outcome among poor children at both the neighbourhood and the individual level, suggesting that neighbourhood characteristics mattered more for poor children than for children who were not poor.

No cross-level interactions were found for teacher-reported scores with regards to child gender or relative poverty status, however there were similar differences in the variability of the outcome between poor and non-poor children. Both the between- and the within-neighbourhood variance in teacher-reported socio-emotional difficulties were greater among children living in relative poverty, although the difference in the between-neighbourhood variability did not reach statistical significance.

7.4 Cross-classified multilevel models - longitudinal analysis

The results of the previous section did not support a mediating role for maternal psychological distress, and the associations with the examined contextual factors were weak or not at all statistically significant. But, the neighbourhood measures available at sweep four were mainly structural measures which might not have adequately captured important aspects such as social processes and mothers' satisfaction with their neighbourhood environment. This section utilises information gathered at sweep two of the study, when interviewers undertook systematic neighbourhood observations and mothers also reported their satisfaction with the local area[1]. About four years lay between sweep two and the measurement of children's socio-emotional difficulties at sweep four (age seven). It is assumed that within this time span, the social environment of most neighbourhoods remained largely the same. Only families who lived in the same neighbourhood at sweep two and sweep four were included in the analyses. For the mother-reported outcome, the analysis sample consisted of 6,668 children, while for the teacher-reported outcome the sample size was 4,414.

7.4.1 Analytical strategy

For each outcome, five models were run:

Model A adjusted for MCS strata and individual level covariates, to ascertain whether there was any between-neighbourhood or between-school variability left after allowing for family background characteristics. The following covariates were included: child gender, child age, SEN status, family income, family social class (NS-SEC), housing tenure, maternal age, maternal education, number of siblings, family structure and child ethnicity. All covariates were measured at sweep four.

Model B then adjusted for the same contextual variables that had been included in the cross-sectional analyses, namely a rural/urban indicator, median household income, the percentage of social housing in the neighbourhood, applicability of school fees, the availability of parks or playgrounds and whether friends or family were living in the area. In

[1] Both measures were described in detail in chapter four (section 4.3.2). Mothers' ratings included overall satisfaction with the area, whether the area was good to bring up children and feelings of safety. Interviewers rated aspects of the neighbourhood such as litter and graffiti, run-down buildings as well as how safe and comfortable they felt in the street. Items were combined via Principal Components Analysis.

addition, the model included maternal neighbourhood perceptions reported at sweep two. Model C additionally adjusted for maternal psychological distress. Here, a measure of cumulative maternal distress was used, indicating whether the mother experienced any distress either never, in the past only, concurrently, or persistently across three consecutive sweeps[1].

Model D adjusted for the same variables as Model B, except that instead of maternal neighbourhood perceptions, it included interviewer-reported neighbourhood disorder measured at sweep two. Model E again adjusted additionally for maternal psychological distress experienced over time.

The results tables present only coefficients for neighbourhood characteristics that were significantly associated with the outcomes (full tables are however provided in Appendix VII).

7.4.2 Socio-emotional difficulties as reported by the mother

The longitudinal analysis sample for mother-reported socio-emotional difficulties included 6,668 children. Table 7-13 lists the number of observations per neighbourhood and school.

Table 7-13 Number of LSOAs and schools / observations per group, mother-reported socio-emotional difficulties, longitudinal analysis sample (N= 6,668)

Groups	Number of groups	Observations per group		
		Min	Average	Max
LSOA's	2,952	1	2.3	29
Schools	2,794	1	2.4	22

Associations with maternal neighbourhood satisfaction

Model A in Table 7-14 shows that as in the cross-sectional analyses, the child and family background characteristics included in the model already explained the between-neighbourhood and between-school variability in the outcome: neither random effect was statistically significant. The relationships with the covariates were similar to the results of the cross-sectional analysis.

[1] The measure of cumulative psychological distress has been described in chapter four (section 4.4.1).

Model B in Table 7-14 shows a strong and linear association between mothers' reports of their child's socio-emotional difficulties at age seven and their neighbourhood satisfaction reported at sweep two, when the child was three years old. Children whose mothers had been least satisfied with their neighbourhood at sweep two scored on average 1.5 points higher on the Total Difficulties scale at sweep four compared to children whose mothers had been most satisfied. Having neither friends nor family in the area was also associated with increased scores, similar to what has been found in the cross-sectional analysis.

The association with maternal neighbourhood satisfaction was attenuated after adjusting for the cumulative measure of maternal psychological distress (Model C in Table 7-14). The coefficients were reduced by about one third, suggesting either mediation or confounding. The relationship remained however linear and highly statistically significant. The average difference between children whose mothers were least satisfied with their neighbourhood at sweep two and children whose mothers were most satisfied was about one point on the Total Difficulties scale, even after allowing for the influence of family-level covariates and symptoms of maternal psychological distress across sweeps. In this model, the between-school variance was borderline statistically significant.

Associations with interviewer observations of neighbourhood disorder

The association with observed neighbourhood disorder was less strong and not entirely linear (Model D in Table 7-14). After adjusting for child and family characteristics, children living in neighbourhoods which interviewers had rated least favourable at sweep two scored on average 0.9 points higher on the mother-reported difficulties scale than children living in neighbourhoods that had been rated most favourably. Adding the measure of maternal psychological distress again attenuated this relationship (Model E in Table 7-14). The reduction in the coefficients for interviewer observed neighbourhood disorder was less striking compared to the changes that were observed for maternal neighbourhood satisfaction as the exposure variable, but still large enough to suggest mediation.

There was a suggestion that associations between the proportion of social housing and mother-reported socio-emotional difficulties were mediated by neighbourhood social processes. In a separate model which did not include maternal neighbourhood satisfaction or observed neighbourhood disorder, the coefficient for the percentage of social housing in the neighbourhood was 0.11 (statistically significant at the 0.05 level, data not shown).

Associations with parenting practices

The three parenting practices measured at sweep two were introduced to Models C and E to test whether their addition led to changes in the coefficients of the neighbourhood variables or the maternal depression variable, neither of which was the case (data not shown).

Associations with social housing

It was noted that there was an association between the outcome and living in social housing also in the longitudinal analysis sample. In Model A, which adjusted for the individual-level covariates only, children whose families were living in social housing scored 0.93 points higher on the Total Difficulties scale compared to children in owned or mortgaged accommodation (coefficients for individual-level covariates shown in Appendix VII, Table 11-12). The coefficient for social housing was reduced to 0.63 after introducing the neighbourhood variables including maternal neighbourhood satisfaction, and to 0.47 after additionally adjusting for maternal psychological distress.

Table 7-14 Cross-classified multilevel models predicting mother-reported total socio-emotional difficulties at age 7, longitudinal analysis (N= 6,668)

	Estimate (Standard Deviation)				
	Model A[1]	**Model B[2]**	**Model C[2]**	**Model D[2]**	**Model E[2]**
% Social housing, per 10%		0.06 (0.04)	0.05 (0.04)	0.07 (0.04)*	0.05 (0.04)
Neither friends nor family in the area		1.05 (0.34)**	0.81 (0.33)**	1.16 (0.34)***	0.89 (0.33)**
No park/playground in the area		0.29 (0.19)	0.19 (0.19)	0.33 (0.19)*	0.21 (0.19)
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Fourth		0.64 (0.17)***	0.52 (0.17)**		
Third		0.84 (0.18)***	0.62 (0.17)***		
Second		1.24 (0.19)***	0.94 (0.18)***		
Least satisfied		1.51 (0.22)***	0.99 (0.21)***		
Interviewer observations sweep two (ref = most favourable)					
Fourth				-0.03 (0.18)	-0.04 (0.17)
Third				0.66 (0.18)***	0.52 (0.18)**
Second				0.60 (0.20)**	0.41 (0.19)*
Least favourable				0.90 (0.22)***	0.75 (0.21)***
Maternal psychological distress over time (ref = none)					
Current (sweep four)			2.61 (0.16)***		2.65 (0.16)***
Past (sweep two and/or sweep three only)			0.99 (0.15)***		1.02 (0.15)***
Persistent (sweeps two, three and four)			3.49 (0.18)***		3.56 (0.18)***
Between neighbourhood variance	0.13 (0.15)^{NS}	0.07 (0.09)^{NS}	0.02 (0.04)^{NS}	0.06 (0.08)^{NS}	0.02 (0.04)^{NS}
Between school variance	0.24 (0.20)^{NS}	0.26 (0.20)^{NS}	0.33 (0.18)	0.24 (0.19)^{NS}	0.32 (0.18)
Residual variance	21.45 (0.42)	21.25 (0.43)	19.64 (0.39)	21.39 (0.43)	19.69 (0.39)
Bayesian DIC (smaller is better)	39,512	39,445	38,937	39,478	38,949

*** p < 0.001   ** p < 0.01   *p < 0.05 ^{NS} Random effect not statistically significant

[1] Adjusted for MCS strata and individual level covariates.   [2] Adjusted for MCS strata, individual level covariates, urban/rural indicator, median household income and school fee-paying status.

7.4.3 Socio-emotional difficulties as reported by the teacher

The sample size for the longitudinal analysis of teacher-reported Total Difficulties scores was 4,414. Table 7-15 presents the number of observations per group within the analysis sample.

Table 7-15 Number of LSOAs and schools / observations per group, teacher-reported socio-emotional difficulties, longitudinal analysis sample (N= 4,414)

Groups	Number of groups	Observations per group		
		Min	Average	Max
LSOA's	2,356	1	1.9	23
Schools	2,148	1	2.1	18
Teachers	2,813	1	1.6	11

Associations with maternal neighbourhood satisfaction

The results of the analysis are shown in Table 7-16. According to Model A and in line with the previous results, there was no statistically significant variability between neighbourhoods and schools after individual-level covariates were accounted for.

Model B in Table 7-16 shows that maternal neighbourhood satisfaction at sweep two was unrelated to teacher reports of children's socio-emotional difficulties at sweep four / age seven. Having neither friends nor family in the area was strongly associated also with more teacher-reported socio-emotional difficulties, with children for whom this was true scoring on average 1.7 points higher compared to their counterparts. The cumulative measure of maternal psychological distress was associated also with teacher-reported socio-emotional difficulties (Model C in table 7-16), but the relationship was less strong than with mother-reported scores, which is in line with the findings from the cross-sectional analyses.

Associations with interviewer observations of neighbourhood disorder

The interviewer observations of neighbourhood disorder recorded at sweep two independently predicted teacher-reported socio-emotional difficulties at sweep four / age seven (Model D in Table 7-16), although the relationship was again not entirely linear. Children living in neighbourhoods that had been given the least favourable rating at sweep two scored on average 0.9 points higher than children living in neighbourhoods that had been rated most favourably, after allowing for the covariates and other contextual measures included in the model. Notably, including the measure of maternal psychological distress to the model did not lead to an important reduction in the coefficients for interviewer ratings (Model E in Table 7-16).

Associations with parenting practices

Again, an additional model was estimated to test whether any of the three parenting practices reported by the mother at sweep two (daily reading, regular bedtime and smacking) was potentially on the pathway between observed neighbourhood disorder and teacher-reported socio-emotional difficulties. None of these variables was independently associated with the outcome, therefore their inclusion did not lead to any sizable reduction in the coefficients of the neighbourhood disorder variable (data not shown).

Associations with social housing

Again, the outcome was related to living in social housing, although the association was weaker compared to mother-reported scores. Children living in social housing scored about 0.5 points higher on the teacher-reported Total Difficulties scale in Model A (results shown in Appendix VII, Table 11-13). The association was however no longer statistically significant once the neighbourhood variables were added to the model (Model B in Table 11-13). Adding the neighbourhood variables separately revealed that it was the percentage of social housing in the neighbourhood that explained the relationship.

Table 7-16 Cross-classified multilevel models predicting teacher-reported total socio-emotional difficulties at age 7, longitudinal analysis (N= 4,414)

	Estimate (Standard Deviation)				
	Model A[1]	**Model B[2]**	**Model C[2]**	**Model D[2]**	**Model E[2]**
% Social housing, per 10%		0.08 (0.06)	0.08 (0.06)	0.07 (0.06)	0.06 (0.06)
Neither friends nor family in the area (sweep four)		1.69 (0.44)***	1.65 (0.44)***	1.69 (0.44)***	1.65 (0.44)***
No park/playground in the area		0.19 (0.25)	0.17 (0.25)	0.19 (0.25)	0.16 (0.25)
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Fourth		-0.06 (0.22)	-0.10 (0.22)		
Third		0.13 (0.23)	0.06 (0.23)		
Second		0.06 (0.24)	-0.04 (0.24)		
Least satisfied		0.31 (0.28)	0.13 (0.28)		
Interviewer observations sweep two (ref = most favourable)					
Fourth				0.44 (0.22)*	0.45 (0.22)*
Third				0.69 (0.23)**	0.66 (0.23)**
Second				0.61 (0.26)**	0.55 (0.26)*
Least favourable				0.90 (0.29)**	0.85 (0.29)**
Maternal psychological distress (ref = none)					
Current (sweep four only)			0.83 (0.21)***		0.82 (0.21)***
Past (sweep two and/or sweep three)			0.48 (0.20)**		0.48 (0.20)**
Persistent (sweeps two, three and four)			1.03 (0.24)***		1.03 (0.24)***
Between neighbourhood variance	0.07 (0.14)[NS]	0.10 (0.11)[NS]	0.08 (0.07)[NS]	0.09 (0.10)[NS]	0.07 (0.07)[NS]
Between school variance	0.78 (0.54)[NS]	0.75 (0.55)[NS]	0.45 (0.51)[NS]	0.88 (0.57)[NS]	0.53 (0.57)[NS]
Between teacher variance	3.16 (0.78)	3.19 (0.82)	3.46 (0.76)	3.11 (0.82)	3.43 (0.80)
Residual variance	20.50 (0.66)	20.33 (0.66)	20.24 (0.65)	20.24 (0.66)	20.15 (0.65)
Bayesian DIC (smaller is better)	26,502	26,482	26,461	26,469	26,448

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ [NS] Random effect not statistically significant

[1] Adjusted for MCS strata and individual level covariates. [2] Adjusted for MCS strata, individual level covariates, urban/rural indicator, median household income and school fee paying status.

7.4.4 Summary

This section analysed longitudinal associations between interviewer observations as well as maternal perceptions of the neighbourhood as the exposure variables, and both mother and teacher reports of children's socio-emotional difficulties four years later, when the children were seven years old.

After allowing for the influence of family background characteristics, children living in neighbourhoods where observed disorder had been highest when they were aged three displayed on average more socio-emotional difficulties at age seven. The size of the association was similar for mother and teacher-reported scores. Maternal neighbourhood satisfaction was also predictive of mother-reported scores but not of socio-emotional difficulties reported by the teacher.

The association between mother-reported socio-emotional difficulties and maternal neighbourhood satisfaction was attenuated after adjusting for maternal psychological distress, which could be due to either mediation or confounding. However, consistent with mediation, the relationship with interviewer-observed neighbourhood disorder was also attenuated once maternal psychological distress was included in the model.

A mediating role for maternal psychological distress could however be ruled out for the association between interviewer observed neighbourhood disorder and teacher-reported socio-emotional difficulties.

In line with the results of the cross-sectional analysis, parenting practices were not found to be on the pathway between neighbourhood factors and the examined child outcomes.

Also similar to the findings of the cross-sectional analyses, the absence of friends and family in the neighbourhood as well as living in social housing were strongly related to both higher mother- and teacher-reported socio-emotional difficulties.

7.5 Chapter summary

The findings of this chapter are summarised in Table 7-17.

Variability in socio-emotional difficulties between neighbourhoods and schools

The cross-sectional analysis partitioned the variability in children's socio-emotional difficulties between neighbourhoods and schools. Before adjusting for any child and family background characteristics, about 4% of the overall variance in mother reported Total Difficulties scores was due to differences between neighbourhoods, and another 6% was due to differences between schools. After allowing for the influence of the family background variables, the differences between neighbourhoods and schools became very small and were no longer statistically significant.

For teacher-reported scores, the unadjusted between-neighbourhood and between-school variance was estimated to be about 3% at each of these levels, while about 13% was between teachers themselves. After adjustments, no statistically significant between-neighbourhood or between-school variability remained. The between-teacher variance was only slightly reduced to 12% of the overall variability in the outcome.

Neighbourhood factors associated with children's socio-emotional difficulties

Of the available neighbourhood-level measures, only the percentage of social housing in the neighbourhood was significantly and positively associated with both mother-reported and teacher-reported socio-emotional difficulties after allowing for the influence of family-level covariates.

The longitudinal analyses showed that among residentially stable families and after allowing for the influence of family background characteristics, living in neighbourhoods that were rated least favourably by the interviewers at sweep two (age three) was associated with on average more socio-emotional difficulties at age seven. The size of the association was almost the same whether the informant was the mother or the teacher. While maternal neighbourhood perceptions at sweep two were also associated with mother reported scores, there was no relationship with teacher reported scores.

Both cross-sectionally and longitudinally, having neither friends nor family in the area was associated with higher Total Difficulties scores from both mother and teacher reports.

In summary, differences in children's socio-emotional difficulties between neighbourhoods and schools were small and were explained by family background factors. However, there were still independent associations with both objective and subjective measures of neighbourhood characteristics.

The role of maternal psychological distress and parenting

The cross-sectional analysis produced no evidence to support the hypothesis that maternal psychological distress was on the pathway between neighbourhood characteristics and children's socio-emotional development. Longitudinally, the relationship between interviewer-observed neighbourhood disorder and child socio-emotional difficulties was attenuated after adjusting for maternal psychological distress, but only if the outcome was reported by the mother. There was no suggestion that the here examined parenting practices were on the pathway between neighbourhood characteristics and children's socio-emotional difficulties.

Cross-level interaction by family income

Tests for cross-level interactions showed that higher neighbourhood median income was associated with lower mother-reported socio-emotional difficulties for children living in relative poverty only, while there was no such association for children whose families were not poor. Further, the between-neighbourhood variability in mother-reported scores was also greater for poor children, suggesting that neighbourhood factors mattered more for children who were materially disadvantaged.

The role of social housing

A consistent finding across the different analysis samples and for both mother and teacher reported outcomes was the association between living in social housing and higher average Total Difficulties scores, when compared to children who lived in owned or mortgaged accommodation. The relationship with mother reports of children's socio-emotional difficulties was slightly attenuated after adjusting for maternal psychological distress in both the cross-sectional and longitudinal analyses. This finding suggests that living in social housing contributed to levels of maternal distress, which is consistent with the results of chapter six.

Table 7-17   Summary table – results of chapter seven

	Cross-sectional		Longitudinal			
	Mother-reported Total Difficulties (N = 9,840)	Teacher-reported Total Difficulties (N = 6,450)	Mother-reported Total Difficulties (N = 6,668)		Teacher-reported Total Difficulties (N = 4,414)	
			Maternal neighbourhood satisfaction	Interviewer observations	Maternal neighbourhood satisfaction	Interviewer observations
VPC unadjusted (empty model)						
Neighbourhood	4.4	2.8	–		–	
School	5.5	3.1	–		–	
Teacher	–	13.2	–		–	
VPC adjusted for family background characteristics						
Neighbourhood	0.8^{NS}	0.2^{NS}	–		–	
School	0.3^{NS}	2.7^{NS}	–		–	
Teacher	–	12.3	–		–	
Evidence for independent association with the proportion of social housing in the neighbourhood?	Yes	Yes	No	Yes	No	No
Evidence for independent association with maternal neighbourhood satisfaction?	–	–	Yes	–	No	–
Evidence for independent association with interviewer observations of neighbourhood disorder?	–	–	–	Yes	–	Yes
Evidence for indirect association via maternal distress?	No	No	Yes	Yes	No	No
Evidence for indirect association via parenting practices?	No	No	No	No	No	No

^{NS} Random effect not statistically significant

Chapter 8

Results – Cognitive development

8 Results – Cognitive development

8.1 Chapter overview

This chapter aimed to examine whether and how much place of residence – via characteristics of neighbourhoods and schools – matters for children's cognitive development. The objectives pertaining to this aim were (1) to partition the variability in cognitive test performance at age seven between families, neighbourhoods and schools; (2) to examine whether neighbourhood and school characteristics contributed to cognitive test performance over and above family socio-economic background; (3) to test whether the relationship between neighbourhood characteristics and the cognitive outcomes was mediated by levels of maternal psychological distress and parenting practices; and (4) to test whether associations varied by family income and child gender.

The cognitive outcomes examined here were children's test performance in reading, maths and spatial visualisation ability. The latter is a test of nonverbal reasoning and was measured via a pattern construction test[1]. The tests were administered by interviewers at sweep four of the study, when the children were seven years old.

8.2 Bivariate analyses

The bivariate analyses used data from sweep four of the study to examine the relationships between cognitive test performance, family background characteristics and neighbourhood factors. To enable comparisons between the three tests, estimates are expressed as a percentage of a standard deviation (% SD)[1] and therefore have a mean of zero and a standard deviation of 100. The three cognitive outcomes were only moderately correlated, as has been shown in chapter four (section 4.6). All descriptive statistics were computed using MCS survey weights and the maximum number of observations available.

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[1] A detailed description of the outcome measures as well as details regarding standardising and scaling has been given in chapter four (section 4.6).

8.2.1 Social gradients in children's cognitive development

Children's performance in all three cognitive tests was socially patterned. Figure 8-1 depicts the mean scores (expressed as a percentage of a standard deviation) by family income quintiles, showing a stepwise social gradient. The difference between children in the bottom and top quintiles was about 75% of a standard deviation for reading, about 70% for maths and about 65% for spatial ability (pattern construction).

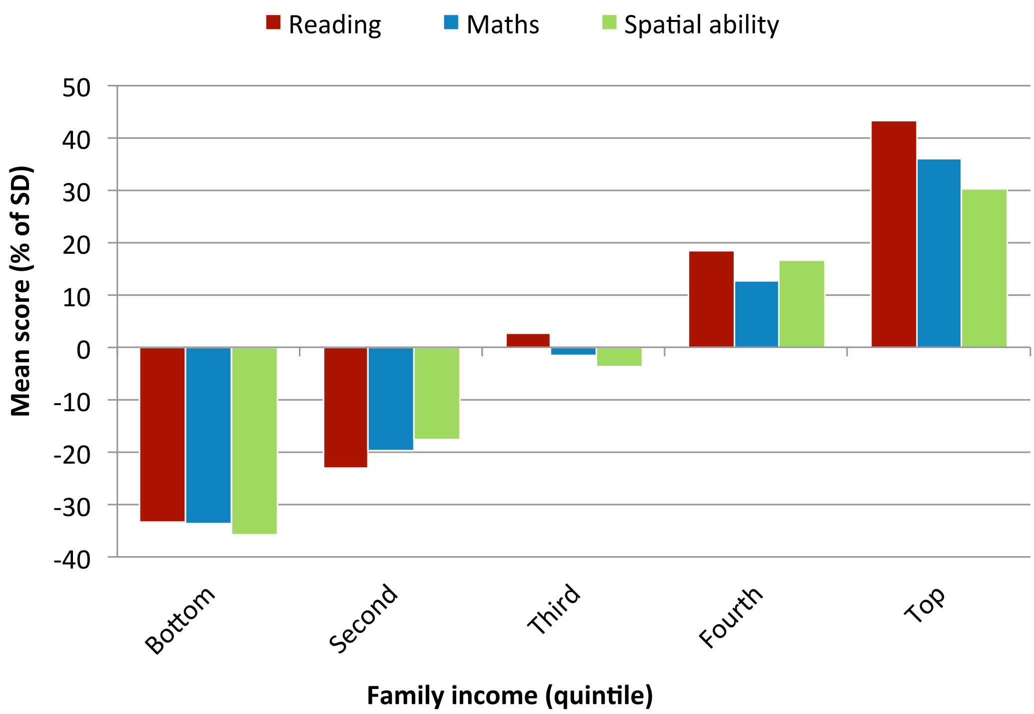

Figure 8-1 Mean cognitive test scores (% SD), by family income

Associations with other child and family background variables are presented in Table 8-1. Family socio-economic characteristics such as social class (measured via NS-SEC), housing tenure and maternal education were strongly associated with cognitive outcomes in the expected directions. The average difference in reading test scores between children whose mothers had no academic or vocational qualifications and children of mothers with the highest level of education was over 90% of a standard deviation. Children living in social housing scored on average 35% of a standard deviation below the sample mean on all three tests.

Girls had on average higher reading scores and also performed better at the spatial ability test, while boys appeared to have a small advantage over girls in maths. Children of older mothers performed better across all measures, for example the average reading score for children whose mothers were younger than thirty was about 32% SD below the sample mean, while for children whose mothers were older than forty it was about 20% SD above. In terms of ethnicity, the picture was mixed: while Indian, Bangladeshi and Black African children outperformed White children in the reading test, they scored on average lower at maths and spatial ability (except Indian children for whom there was no difference). If a language other than English was spoken at home, this appeared to have a positive effect on reading but a negative effect on maths and spatial ability, however the measure might be confounded by the effect of ethnicity.

Table 8-1 Mean cognitive test scores at age 7 (expressed as percentages of a standard deviation) and standard errors, by family and child characteristics (max. N = 12,957)

	Reading	Maths	Spatial ability
Child gender			
Boy	-6.20 (2.27)	1.20 (2.74)	-4.53 (2.02)
Girl	10.75 (1.78)	-2.86 (2.39)	1.63 (2.15)
Income quintile			
Top	43.15 (2.81)	35.94 (3.02)	30.17 (2.77)
Fourth	18.49 (2.26)	12.69 (2.75)	16.74 (2.37)
Third	2.59 (2.22)	-1.61 (2.92)	-3.46 (2.43)
Second	-22.88 (2.58)	-19.76 (2.98)	-17.53 (2.43)
Bottom	-33.43 (2.94)	-33.71 (3.45)	-35.78 (3.20)
NS-SEC (combined)			
Managerial / professional	32.51 (2.14)	26.76 (2.40)	22.89 (2.07)
Intermediate	9.70 (2.84)	3.13 (3.66)	1.79 (3.18)
Small empl. / self empl.	-5.53 (3.55)	-5.13 (4.06)	3.74 (3.45)
Lower supervisory / tech.	-12.25 (4.64)	-16.16 (4.49)	-6.85 (4.80)
Semi routine / routine	-24.08 (2.75)	-26.73 (3.33)	-26.42 (2.94)
No parent in work	-36.41 (2.89)	-32.92 (3.24)	-35.37 (2.89)
Housing tenure			
Own / mortgage	20.14 (2.00)	14.02 (2.43)	13.41 (1.88)
Rent privately	-18.21 (3.98)	-10.24 (4.40)	-9.36 (4.04)
Social housing	-35.31 (2.50)	-33.95 (3.05)	-35.09 (2.60)
Other[2]	-8.41 (8.20)	-12.67 (8.10)	-19.53 (6.30)
Maternal age at interview			
40 plus	19.60 (2.48)	10.44 (3.01)	9.45 (2.49)
30 – 39	4.99 (1.94)	2.10 (2.41)	1.60 (1.98)
20 – 29	-32.31 (3.16)	-25.82 (3.83)	-26.88 (2.92)

	Reading	Maths	Spatial ability
Maternal NVQ level			
Level 4/5	31.77 (2.12)	25.45 (2.40)	22.22 (2.04)
Level 3	7.59 (3.08)	1.36 (3.03)	3.47 (2.78)
Level 2	-7.41 (2.41)	-6.76 (2.98)	-5.39 (2.24)
Level 1	-31.28 (3.96)	-28.47 (4.63)	-25.60 (4.20)
Overseas only	-14.23 (7.55)	-19.79 (6.98)	-30.16 (6.36)
None	-50.69 (4.12)	-50.12 (4.20)	-52.52 (3.53)
Number of siblings			
None	4.62 (3.43)	1.11 (3.84)	-4.16 (2.88)
One	12.56 (1.89)	6.36 (2.36)	6.05 (1.97)
Two	-2.72 (2.60)	-3.77 (2.80)	-2.40 (2.29)
Three	-23.27 (4.08)	-17.29 (3.98)	-20.57 (3.73)
Four	-31.52 (6.45)	-27.40 (7.92)	-29.29 (7.91)
Five or more	-42.56 (7.78)	-34.95 (8.41)	-30.94 (9.62)
Family structure			
Both natural parents	12.65 (1.91)	7.08 (2.36)	6.24 (1.92)
Natural mother/other	-26.46 (4.40)	-17.74 (4.75)	-11.75 (4.18)
Single mother	-21.93 (2.60)	-20.11 (3.28)	-22.93 (2.59)
Child ethnicity			
White	0.77 (1.93)	2.48 (2.41)	4.21 (1.78)
Mixed	10.04 (6.78)	-2.49 (6.89)	-15.43 (6.86)
Indian	38.25 (8.25)	13.89 (9.37)	-13.69 (8.24)
Pakistani	3.41 (6.36)	-46.22 (8.13)	-57.98 (6.53)
Bangladeshi	21.03 (9.38)	-47.03 (7.24)	-31.18 (6.46)
Black Caribbean	-13.96 (14.76)	-27.42 (13.66)	-63.21 (15.09)
Black African	23.58 (5.28)	-27.56 (10.28)	-67.31 (9.31)
Other (incl. Chinese)	-1.25 (10.52)	-14.26 (10.14)	-15.94 (7.46)
Language spoken at home			
English only	1.18 (1.87)	1.78 (2.34)	1.67 (1.76)
Mostly English	19.25 (5.19)	-15.81 (6.54)	-20.08 (5.55)
Half English, half other	20.33 (6.82)	-20.17 (8.31)	-38.59 (7.22)
Mostly other	-7.54 (8.49)	-44.12 (6.94)	-42.10 (6.80)
Other language only	-22.71 (14.74)	-45.08 (14.79)	-48.57 (16.55)

[2] Includes living with parents

8.2.2 Neighbourhood characteristics and cognitive development

Examined here were associations of cognitive outcomes with the “Education and skills” domain of the IMD, neighbourhood median household income and the rural/urban indicator. Median household income ranged from £8,000 to £78,000[1]. Figures 8-2 and 8-3 show the associations between the two compositional neighbourhood measures and children’s cognitive test scores. Across all three outcomes there were strong social gradients: children living in neighbourhoods where median income was high and where there was low deprivation in terms of education and skills tended to have higher test scores. The two figures look broadly similar regarding the magnitudes and gradients of the associations. The strength of the associations appeared to vary somewhat across outcomes, for example, reading test scores showed a stronger association with median neighbourhood income than the other two outcomes. Differences between the lowest and highest deciles spanned up to 70% of a standard deviation for reading test scores and up to 60% of a standard deviation for maths test scores.

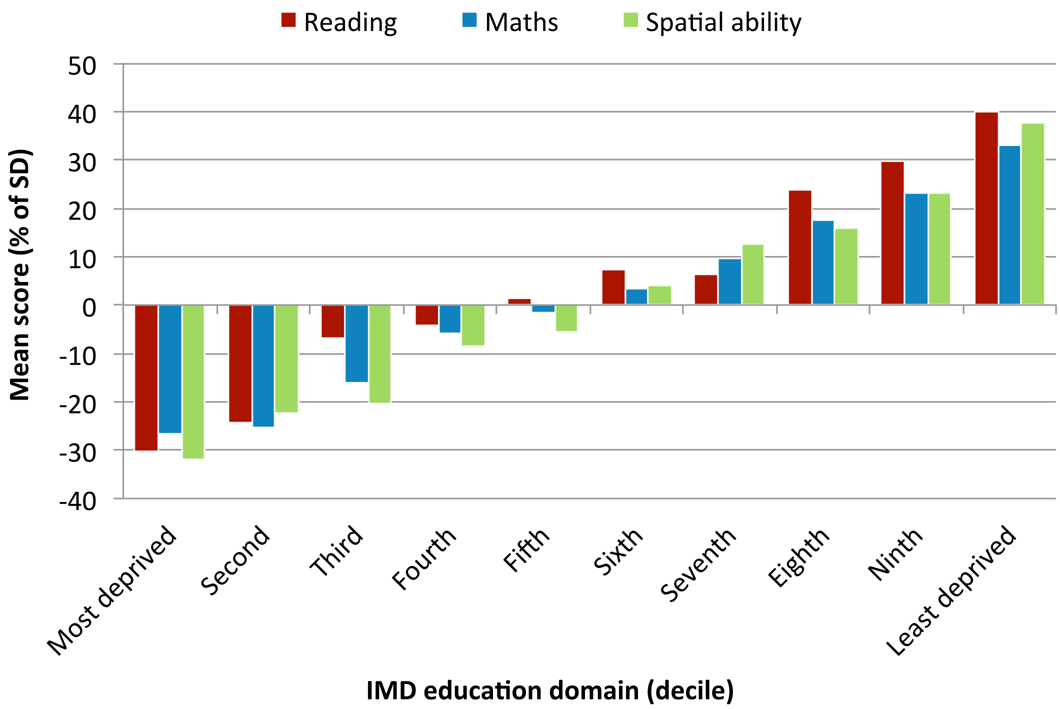

Figure 8-2 Mean cognitive test scores at age 7 (% SD), by IMD education domain

[1] Detailed descriptions of these measures were given in chapter four (section 4.3.1).

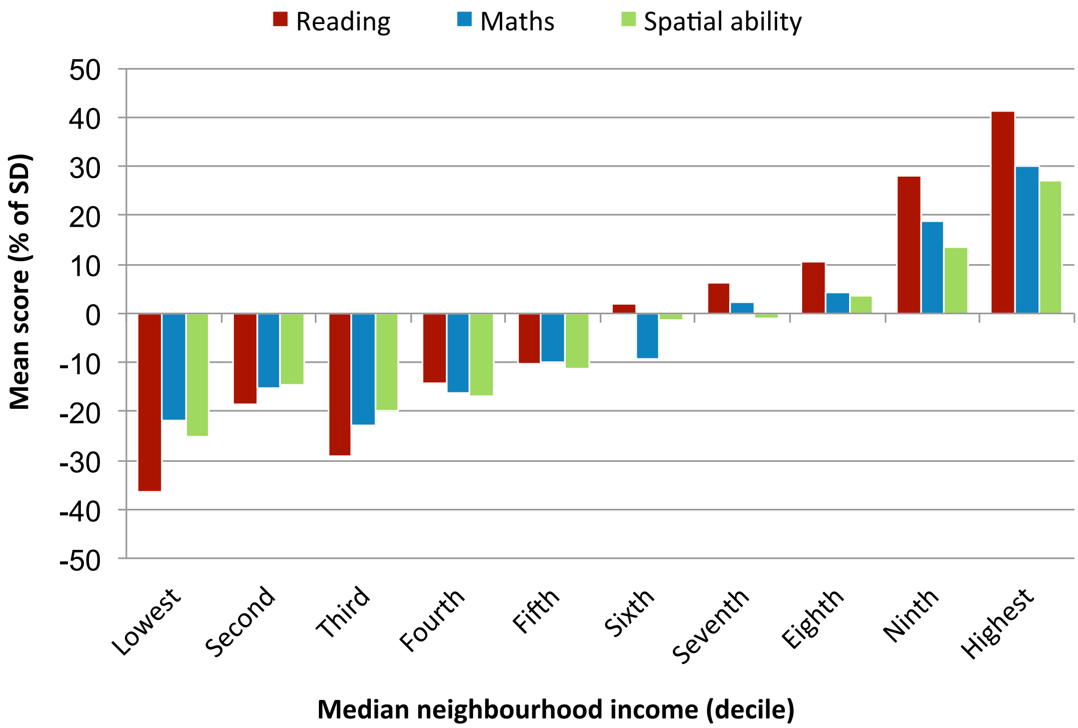

Figure 8-3 Mean cognitive test scores at age 7 (% SD), by median neighbourhood income

The other two contextual variables that were available at sweep four were the rural/urban indicator and whether school fees were applicable. The associations with these factors are shown in Table 8-2. Children in rural areas had on average slightly higher test scores than children in urban areas. The average difference was highest for the spatial ability test with 18% SD, but negligible (and not statistically significant) for reading with about 3% of a standard deviation. Children in fee-paying schools scored considerably higher across all the tests, an association that is likely to be confounded by their family background.

Table 8-2 Mean cognitive test scores at age 7 (% SD) and standard errors, by rural/urban indicator and school fee-paying status (max. N = 12,957)

	% of N	Reading	Maths	Spatial ability
Rural	23.2	4.51 (2.79)	8.69 (2.76)	12.37 (2.90)
Urban	76.8	1.37 (2.13)	-3.50 (8.69)	-5.51 (2.14)
School fees payable	3.5	64.71 (4.85)	46.34 (6.37)	40.69 (4.64)
Non fee-paying school	96.5	-0.30 (1.66)	-2.58 (2.30)	-3.01 (1.81)

8.2.3 Maternal psychological distress and cognitive development

The relationship between maternal levels of distress and cognitive test scores is shown in Table 8-3. The average test scores of children whose mothers reported symptoms of moderate distress lay between 8% and 10% of a standard deviation below the sample mean. Children whose mothers experienced symptoms of severe distress scored on average 25% of a standard deviation below the sample mean in reading, 30% below the mean in maths and 40% below the mean in the spatial ability test. When maternal psychological distress was considered over time, it appeared that concurrent and persistently experienced distress (but not distress experienced only in the past) was associated with lower cognitive test scores.

Table 8-3 Mean cognitive test scores at age 7 (expressed as percentage of a standard deviation) and standard errors, by maternal distress (max. N = 12,378)

	% of N	Reading	Maths	Spatial ability
Maternal distress sweep 4 (child aged 7)				
None	68.4	10.21 (1.85)	7.84 (2.36)	6.30 (1.77)
Moderate	28.0	-9.35 (2.63)	-10.43 (2.85)	-7.86 (2.58)
Severe	3.6	-25.67 (6.80)	-29.95 (6.44)	-39.00 (6.49)
Maternal distress over time (between sweeps two and four, child aged 3-7)[1]				
Never	48.8	16.95 (2.09)	13.96 (2.41)	14.67 (1.97)
Past only	20.4	4.20 (2.81)	2.68 (3.48)	-1.31 (2.74)
Concurrent	17.3	-6.98 (3.52)	-6.03 (3.60)	-4.93 (3.53)
Persistent	13.6	-9.92 (3.92)	-11.61 (4.08)	-9.87 (3.70)

[1] "Any maternal psychological distress" includes all mothers with a score higher than 3 on the Kessler-6 scale.

8.3 Cross-classified multilevel models - cross-sectional analysis

In this section, the variance in the three cognitive test outcomes was decomposed to quantify the contribution of neighbourhoods and schools, before and after adjusting for family socio-demographic background characteristics. In addition, it was tested whether and how much the available contextual measures contributed towards explaining the variability between neighbourhoods and schools, whether maternal psychological distress and parenting practices mediated these relationships and whether associations varied by child gender and family income.

8.3.1 Analytical strategy

Consistent with the approach taken in the previous chapters, the following analyses only included children who neither changed school nor moved to a different neighbourhood since at least sweep three / age five. With these constraints, the analysis sample consisted of 9,412 children with complete information on all three outcomes, neighbourhood exposures and covariates. The analyses in this section were cross-sectional, using only measures from sweep four of the study. The children's mean age was 7 years and 3 months, and 50.4% of them were boys.

Table 8-4 Number of LSOA's and schools / observations per group, cognitive test performance cross-sectional analysis sample (N = 9,412)

Groups	Number of groups	Observations per group		
		Min	Average	Max
LSOA's	4,271	1	2.2	32
Schools	3,787	1	2.5	25

As in the previous chapter, all models were run using the Markov Chain Monte Carlo (MCMC) estimation method. For each outcome, a series of seven models was estimated:

Model A and Model B: The first two models were the variance components models (or empty models), run without any explanatory variables. Model A was a two-level model with neighbourhoods as the higher level. Next, a cross-classified model was estimated (Model B), showing the effect of additionally taking schools into account. The cross-classified model provided estimates of the total variance in cognitive outcomes between neighbourhoods, schools and children/families.

Model C: Model C adjusted for the MCS design strata and for the battery of individual level covariates. These were the child's gender, child age in days at the time of the interview[1] (scaled so that one unit represented one month), whether the child had a statement of special educational needs (SEN), weekly family income (scaled so that one unit represented £100), family NS-SEC, housing tenure, mother's age in years, maternal education (NVQ level), child ethnicity, whether a language other than English was spoken in the home and the school year the child was in at the time of the interview[2]. The percentage of the neighbourhood and school variance that was explained by these factors can be thought of as due to neighbourhood and school composition.

Model D: Then, the available neighbourhood and school level exposures were added to the model. The contextual exposures used in this analysis were neighbourhood median household income (scaled so that one unit represented £1000), the education domain of the IMD[3] and a rural/urban indicator. The only measure available at school level was whether school fees were applicable[4]. Having friends or family in the area was not independently associated with any of the cognitive outcomes, and neither was the availability of parks and playgrounds in the neighbourhood. These measures were therefore not included in the final models.

Model E: The next model included the Kessler-6 score as a measure of maternal psychological distress, used as a continuous variable.

Model F: The relationship between maternal distress and cognitive test outcomes might be confounded (or mediated) by the presence of behavioural difficulties in the child, therefore the effect of adding a measure of child behaviour – the Total Difficulties score of the mother-reported SDQ – to the model was also tested.

Model G: Model G additionally estimated associations with the parenting behaviours (daily reading, regular bedtimes and smacking), to test whether these factors were mediating any

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[1] The standardised measures of cognitive test performance are age-adjusted in three-months bands, therefore child age in days was included as a covariate following Carson et al. (2011) and Kelly et al. (2013).

[2] The majority of children were in year 2 at the time of the interview, but some were in other year groups.

[3] A detailed description of this measure has been given in chapter four (section 4.3.1).

[4] The dataset contains a variable on mother's satisfaction with the school, however it was not used in the analysis because it did not at all contribute towards explaining variability between schools. It appeared that mothers were satisfied if the child was doing well.

of the above associations. Models F and G in this section only display the coefficients of the relevant neighbourhood characteristics, however full tables can be found in Appendix VIII (Tables 11-14 to 11-16).

For each model, the total unexplained variance was estimated as well as the percentage of the unexplained variance due to neighbourhoods and schools (VPC). Also presented are the percentages of the total neighbourhood and school variance that were explained by the variables in the model. As before, the Bayesian DIC provided an indication of model fit.

8.3.2 Reading

The variance components for reading test performance are presented in Table 8-5. According to the two-level model, 10.7% of the total variance in test performance was due to differences between neighbourhoods (Model A). The inclusion of the school level (Model B) revealed that in Model A parts of the overall variance had been wrongly attributed to families and neighbourhoods. The cross-classified model (B) attributed 5.4% of the overall variance to neighbourhoods and 10.2% to schools, so that together, schools and neighbourhoods accounted for 15.6% of the overall variance. The Bayesian DIC was reduced by about 200, a strong indication that the three-level cross classified model fitted the data much better.

Table 8-5 Variability in reading test performance – comparison of two-level and three-level cross-classified variance components models (MCMC estimation, N = 9,412)

	Estimate (Standard Deviation)	
	Two-level model (A)	**Three-level cross-classified model (B)**
Intercept	4.96 (1.15)	4.83 (1.23)
Neighbourhood variance	1,031.07 (115.44)	520.78 (121.73)
School variance	–	989.83 (126.79)
Residual variance	8,633.89 (153.34)	8,154.54 (156.74)
Total variance	9,644.96	9,665.15
% of total variance due to neighbourhoods	**10.7**	**5.4**
% of total variance due to schools	–	**10.2**
Bayesian DIC (smaller is better)	112,802	112,605

Adjusting for the individual-level covariates (Model C in Table 8-6) substantially reduced both neighbourhood and school variance. About 90% of the neighbourhood and 50% of the total school level variance were explained by this model. The neighbourhood variance was no longer statistically significant (DIC without random neighbourhood effect = 110,976), suggesting that neighbourhood differences in reading were mainly due to compositional effects. However, schools still accounted for 6.5% of the remaining unexplained variance.

Of the fixed effects, maternal education showed the strongest association with the outcome, with children whose mothers had no qualifications scoring almost 40% of a standard deviation lower than children of mothers with the highest qualifications. Children living in social housing scored about 16% SD lower than children living in owned/mortgaged accommodation. Ethnic minority children scored substantially higher than White children (except Black Caribbean children for whom there was no difference). Whether or not other languages than English were spoken at home was not independently associated with reading test performance (data not shown). Children who were in year 1 at the time of the interview scored about 66% SD lower than children in year 2, while there was no difference for year 3 children (data not shown). The negative coefficient for age reflects the relatively stronger performance of the very young and relatively poorer performance of the oldest children in the sample, compared to the BAS standardisation sample.

Model D added the contextual measures, which explained only a further 4% of the school-level variance. Individual level covariates taken into account, children from rural areas had slightly lower scores compared to children living in urban areas (-6% SD). Median household income in the neighbourhood was positively associated with reading. For every £1000 increase in median income, average reading scores increased by 0.8% SD. A rise in median income of £20,000 corresponded therefore to an increase in average reading scores by 16% SD. Note that while median income ranged from £8,000 to £78,000, the distribution was positively skewed with a mean of £24,000. The education domain of the IMD did not contribute additionally. Children attending fee-paying schools scored on average 14% SD higher compared to children attending non-fee paying schools. In this model, 6.1% of the unexplained variance was between schools.

Testing the role of maternal psychological distress

Adding maternal psychological distress to the model (Model E in Table 8-6) slightly improved model fit and showed a weak but statistically significant negative association between the reading score and maternal distress (-0.7% SD for each point increase on the Kessler-6 scale). The fixed effects for the neighbourhood measures remained however unchanged. Neither neighbourhood nor school variance changed substantially. Looking at the individual level covariates, there were no important changes in any of these variables. The results therefore did not support the hypothesis of maternal psychological distress contributing to neighbourhood effects on reading test performance.

Testing the role of child behaviour

The results for models testing the role of socio-emotional difficulties and parenting practices are presented in Table 8-7. The association between socio-emotional difficulties and reading test performance itself was strong, which was also reflected in the much improved model fit (Model F in Table 8-7). For each point increase in the Total Difficulties score there was an average decrease of nearly 3% SD in the reading score. Adding the indicator of child socio-emotional difficulties resulted in the coefficient for maternal psychological distress changing sign, meaning that a higher Kessler-6 score was associated with slightly better reading test performance when child behaviour was held constant. The relationship with living in social housing was somewhat attenuated (data shown in Appendix VIII, Table 11-14). Looking at the random effects, adjusting for behavioural difficulties did however not help to explain differences in test performance between schools (differences between neighbourhoods were already explained by the previous models). This is in line with the findings of the previous chapter, which showed that there were no statistically significant differences between schools in mother-reported socio-emotional difficulties once family level covariates had been accounted for.

Testing the role of parenting practices

At age seven, daily reading to the child was related to slightly *lower* scores in the reading test. It might be that by that age, children who are good readers have started to read by themselves (Model G in table 8-7). Children with no regular bedtime had lower test scores with an average reduction of 10% SD, compared to children who went to bed at regular times. The use of smacking as a parenting strategy was unrelated to reading test performance. Adding the parenting measures did not lead to a reduction in the coefficient for median neighbourhood income, therefore there was no indication of mediation.

Table 8-6 Results of cross-classified multilevel models predicting reading test performance (N = 9,412)

	Estimate (Standard Deviation)[1]		
	Model C	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	-2.14 (2.90)	2.76 (3.02)	2.78 (3.02)
England – ethnic	14.34 (4.90)**	18.62 (4.95)***	18.51 (4.96)***
Wales – advantaged	-23.48 (5.11)***	-19.69 (5.18)***	-19.94 (5.19)***
Wales – disadvantaged	-36.02 (3.96)***	-28.43 (4.10)***	-28.54 (4.08)***
Scotland – advantaged	-4.88 (4.51)	5.73 (5.20)	5.41 (5.22)
Scotland – disadvantaged	-7.28 (4.58)	4.85 (5.10)	4.79 (5.08)
NI – advantaged	-30.28 (5.19)***	-18.23 (6.09)**	-18.61 (6.09)**
NI – disadvantaged	-34.78 (4.54)***	-19.91 (5.18)***	-20.31 (5.16)***
Child and family level			
Girl	11.34 (1.83)***	11.33 (1.82)***	11.25 (1.82)***
Child age in months	-2.27 (0.32)***	-2.33 (0.32)***	-2.32 (0.32)***
Has SEN statement	-78.12 (3.63)***	-78.13 (3.62)***	-77.66 (3.63)***
Weekly family income per £100	3.46 (0.56)***	2.43 (0.58)***	2.33 (0.58)***
NS-SEC (ref= manag. / prof.)			
Intermediate	-10.14 (3.14)**	-9.33 (3.14)**	-9.32 (3.13)**
Small empl. / self empl.	-12.77 (3.58)***	-12.16 (3.55)***	-12.23 (3.55)***
Lower supervisory / tech.	-11.59 (4.21)**	-10.13 (4.26)**	-10.17 (4.25)**
Semi routine / routine	-20.15 (3.27)***	-18.69 (3.26)***	-18.59 (3.25)***
No parent in work	-15.48 (3.63)***	-15.28 (3.61)***	-14.61 (3.60)***
Housing tenure (ref= owner)			
Rented privately	-4.69 (4.33)	-4.70 (4.30)	-4.37 (4.26)
Social housing	-16.11 (3.02)***	-14.50 (3.04)***	-14.15 (3.05)***
Other	7.73 (6.89)	7.13 (6.89)	7.25 (6.85)
Maternal age (years)	0.55 (0.18)**	0.41 (0.18)*	0.43 (0.19)*
Maternal NVQ (ref = level 4/5)			
Level 3	-7.12 (2.85)**	-5.66 (2.86)*	-5.67 (2.83)*
Level 2	-13.18 (2.53)***	-11.94 (2.54)***	-11.89 (2.54)***
Level 1	-31.84 (4.04)***	-30.27 (4.05)***	-30.30 (4.05)***
Overseas only	-24.24 (6.70)***	-23.77 (6.70)***	-23.47 (6.70)***
None	-39.32 (3.91)***	-37.50 (3.92)***	-37.10 (3.89)***
Number of siblings (ref = none)	-6.41 (0.96)***	-6.60 (0.95)***	-6.61 (0.95)***

Table 8-6 (continued)

	Estimate (Standard Deviation)[1]		
	Model C	**Model D**	**Model E**
Family structure (ref = both natural parents)			
Natural mother / other partner	-13.17 (4.36)**	-12.93 (4.35)**	-12.59 (4.34)**
Single mother	-5.00 (2.87)*	-5.53 (2.87)*	-5.24 (2.86)*
Child ethnicity (ref = White)			
Mixed	10.04 (6.20)	9.24 (6.16)	9.59 (6.14)
Indian	23.88 (7.71)**	19.01 (7.76)**	19.29 (7.76)**
Pakistani	18.93 (7.46)**	18.17 (7.41)**	18.60 (7.43)**
Bangladeshi	21.92 (10.73)*	21.64 (10.64)*	21.83 (10.68)*
Black Caribbean	-4.59 (9.01)	-7.52 (8.95)	-7.23 (8.94)
Black African	34.88 (8.69)***	32.19 (8.65)***	32.01 (8.66)***
Other (incl. Chinese)	12.50 (9.16)	8.46 (9.18)	9.31 (9.20)
Neighbourhood level			
Rural (ref = urban)		-6.40 (2.55)**	-6.40 (2.52)**
Median household income, per £1000		0.78 (0.20)***	0.77 (0.20)***
IMD education domain, per decile (ref=most deprived)		0.62 (0.61)	0.61 (0.61)
School level			
Fees applicable		13.60 (6.03)*	13.57 (6.06)*
Maternal distress (Kessler-6 score)			-0.71 (0.25)**
Constant	213.55 (29.15)	206.25 (29.37)	207.39 (29.32)
Neighbourhood variance	50.85 (50.43)^{NS}	46.37 (54.67)^{NS}	11.43 (22.95)^{NS}
% of total neighbourhood variance explained	90.2	91.1	97.8
School variance	510.22 (80.17)	473.63 (80.72)	489.68 (78.11)
% of total school variance explained	48.5	52.2	50.5
Residual variance	7,259.35 (127.58)	7,252.67 (127.77)	7,266.36 (123.27)
Total unexplained variance	7,820.42	7,772.67	7,767.47
% of unexplained variance due to neighbourhoods	0.7	0.6	0.1
% of unexplained variance due to schools	6.5	6.1	6.3
Bayesian DIC (smaller is better)	110,974	110,937	110,931

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ ^{NS} Random effect not statistically significant

[1] Covariates include school year and language spoken in the home (data not shown)

Table 8-7 Testing the role of child behaviour and parenting practices - results of cross-classified multilevel models predicting reading test performance (N = 9,412)

	Estimate (Standard Deviation)		
	Model E[1]	**Model F[2]**	**Model G[3]**
Neighbourhood level			
Rural (ref = urban)	-6.40 (2.52)**	-6.21 (2.50)**	-6.07 (2.50)**
Median household income, per £1000	0.77 (0.20)***	0.78 (0.20)***	0.81 (0.20)***
IMD education domain, per decile (ref=most deprived)	0.61 (0.61)	0.34 (0.61)	0.28 (0.61)
School level			
Fees applicable	13.57 (6.06)*	12.38 (6.01)*	12.88 (5.95)*
Maternal psychological distress (Kessler-6 score)	-0.71 (0.25)**	0.47 (0.26)*	0.46 (0.26)*
Child behaviour (Total Difficulties score)		-3.03 (0.20)***	-2.98 (0.20)***
Parenting practices			
Mother reads daily			-6.76 (1.85)***
No regular bedtime			-9.62 (3.13)**
Smacking			-1.08 (1.82)
Constant	207.39 (29.32)	248.41 (29.07)	252.55 (29.09)
Neighbourhood variance	11.43 (22.95)^{NS}	9.66 (20.29)^{NS}	4.27 (23.80)^{NS}
% of total neighbourhood variance explained	97.8	98.1	99.2
School variance	489.68 (78.11)	511.39 (79.53)	523.87 (77.32)
% of total school variance explained	50.5	51.7	47.1
Residual variance	7,266.36 (123.27)	7,065.42 (121.55)	7,046.46 (120.44)
Total unexplained variance	7,767.47	7,577.47	7,574.60
% of unexplained variance due to neighbourhoods	0.1	0.1	0.1
% of unexplained variance due to schools	6.3	6.7	6.9
Bayesian DIC (smaller is better)	110,931	110,693	110,677

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ ^{NS} Random effect not statistically significant

[1] Model E same as in table 8-6 (adjusted also for MCS strata and individual level covariates, data shown in Appendix VIII)

[2] Model F = Model E + mother-reported socio-emotional difficulties

[3] Model G = Model F + parenting practices

8.3.3 Maths

Table 8-8 shows the variance components models for maths test performance. Again, the cross-classified model (Model B) was a much better fit to the data compared to the two-level model (A). Model B shows that 8.6% of the overall variance was due to differences between neighbourhoods and 11.5% was due to differences between schools. This means that overall, as much as 20% of the unadjusted variance in maths test scores was due to differences at the higher levels.

Table 8-8 Variability in maths test performance – comparison of two-level and three-level cross-classified variance components models (MCMC estimation, N = 9,412)

	Estimate (Standard Deviation)	
	Two-level model (A)	**Three-level cross-classified model (B)**
Intercept	5.62 (1.20)	6.44 (1.26)
Neighbourhood variance	1,566.24 (131.18)	828.49 (135.82)
School variance	–	1,110.30 (133.04)
Residual variance	8,153.92 (148.13)	7,729.76 (148.30)
Total variance	9,720.16	9,668.55
% of total variance due to neighbourhoods	**16.1**	**8.6**
% of total variance due to schools	–	**11.5**
Bayesian DIC (smaller is better)	112,575	112,378

Adjusting for individual level covariates (Model C in Table 8-9) explained only 28% of the total neighbourhood and 26% of the total school variance in maths test scores. Of the variance that was not explained by compositional factors, 7% could be attributed to neighbourhoods and 10% to schools. Girls scored about 8% SD lower than boys in the maths test. The family level factor that appeared to be most important was again maternal education. Children living in social housing scored about 13% SD lower in the maths test compared to children living in owned/mortgaged housing. Maternal age was not significantly associated with the outcome. Pakistani, Bangladeshi and Black African children had on average lower scores than White children. As for reading, the language spoken at home was also not independently associated with children's maths test performance. Children in year one scored on average 50% of an SD lower (data not shown).

Introducing the neighbourhood variables (Model D) resulted in a further small reduction in the unexplained school variance, but not in the neighbourhood variance. The only neighbourhood variable that was significantly associated with maths test performance was neighbourhood median household income. For every £1000 increase, the maths test score increased on average by 0.5% SD. Children in fee-paying schools scored on average 12% SD higher. The model left large parts of the neighbourhood and school variance unexplained and estimated that 7.1% of the unexplained variance was between neighbourhoods and 9.4% was between schools.

Testing the role of maternal psychological distress

Model E in table 8-9 shows the associations after introducing maternal psychological distress to the model. Maternal distress was significantly and negatively associated also with performance in maths, and the model fit was clearly improved. The size of the association was a little bigger than for reading (about -1.1% SD per point increase in the Kessler-6). However, the fixed effect for median household income, which was the only neighbourhood variable significantly associated with maths test performance, remained unchanged. As before, there were no changes in the neighbourhood and school variance.

Testing the role of child behaviour

Adding the child behaviour variable (Model F in Table 8-10) led to a marked reduction in the fixed effect for maternal distress, which was then close to zero and no longer statistically significant. The association between behavioural difficulties and maths test performance was negative and its size similar to that for reading. Including child behavioural difficulties explained some of the between-neighbourhood variance but led to a small increase in the between-school variance. Again, the association with living in social housing was also slightly attenuated (data shown in Appendix VIII, Table 11-15).

Testing the role of parenting practices

The here included parenting behaviours did not help to explain the variability in maths test scores between neighbourhoods and schools. Again, there was a negative association with daily reading, while regular bedtimes and smacking were not related to maths test performance (Model G in table 8-10).

Table 8-9 Results of cross-classified multilevel models predicting maths test performance (N = 9,412)

	Estimate (Standard Deviation)[1]		
	Model C	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	-0.15 (3.24)	4.92 (3.39)	4.97 (3.39)
England – ethnic	11.24 (5.32)*	15.81 (5.41)**	15.70 (5.41)**
Wales – advantaged	5.21 (5.86)	6.93 (5.95)	6.55 (5.97)
Wales – disadvantaged	-4.44 (4.50)	1.76 (4.69)	1.72 (4.66)
Scotland – advantaged	-10.84 (5.03)*	-4.69 (5.82)	-5.15 (5.86)
Scotland – disadvantaged	-11.72 (5.05)*	-2.65 (5.67)	-2.68 (5.65)
NI – advantaged	-2.31 (6.10)	4.53 (7.05)	4.06 (7.07)
NI – disadvantaged	10.10 (5.32)*	19.79 (6.03)**	19.27 (6.03)**
Child and family level			
Girl	-7.65 (1.88)***	-7.69 (1.88)***	-7.82 (1.87)***
Child age in months	-3.35 (0.34)***	-3.39 (0.34)***	-3.38 (0.34)***
Has SEN statement	-66.22 (3.74)***	-66.28 (3.74)***	-65.57 (3.76)***
Weekly family income per £100	3.14 (0.58)***	2.39 (0.60)***	2.24 (0.60)***
NS-SEC (ref= manag. / prof.)			
Intermediate	-10.23 (3.24)**	-9.65 (3.23)**	-9.66 (3.23)**
Small empl. / self empl.	-11.72 (3.68)**	-11.60 (3.66)**	-11.72 (3.65)***
Lower supervisory / tech.	-14.22 (4.34)**	-13.10 (4.39)**	-13.16 (4.38)**
Semi routine / routine	-19.33 (3.37)***	-18.29 (3.35)***	-18.22 (3.35)***
No parent in work	-12.75 (3.74)***	-12.63 (3.73)***	-11.64 (3.73)**
Housing tenure (ref= owner)			
Rented privately	-5.75 (4.49)	-6.03 (4.46)	-5.62 (4.42)
Social housing	-12.77 (3.15)***	-11.39 (3.17)***	-10.91 (3.18)***
Other	9.67 (7.10)	8.82 (7.10)	9.01 (7.07)
Maternal age (years)	0.13 (0.19)	0.02 (0.19)	0.04 (0.19)
Maternal NVQ (ref = level 4/5)			
Level 3	-8.67 (2.94)**	-7.61 (2.95)**	-7.65 (2.92)**
Level 2	-13.20 (2.61)***	-12.15 (2.63)***	-12.13 (2.63)***
Level 1	-24.10 (4.17)***	-22.86 (4.17)***	-22.97 (4.16)***
Overseas only	-16.29 (6.91)**	-15.69 (6.92)*	-15.20 (6.90)*
None	-33.86 (4.03)***	-32.30 (4.05)***	-31.76 (4.02)***
Number of siblings (ref = none)	-1.12 (0.99)	-1.29 (0.98)	-1.29 (0.99)

Table 8-9 (continued)

	Estimate (Standard Deviation)[1]		
	Model C	**Model D**	**Model E**
Family structure (ref = both natural parents)			
Natural mother / other partner	-5.49 (4.52)	-5.24 (4.49)	-4.74 (4.49)
Single mother	-2.11 (2.95)	-2.26 (2.96)	-1.80 (2.95)
Child ethnicity (ref = White)			
Mixed	0.11 (6.44)	0.12 (6.39)	0.56 (6.37)
Indian	7.86 (8.10)	5.39 (8.17)	5.72 (8.17)
Pakistani	-24.05 (7.90)**	-23.58 (7.87)**	-22.92 (7.90)**
Bangladeshi	-32.05 (11.21)**	-31.19 (11.15)**	-31.10 (11.17)**
Black Caribbean	-13.72 (9.48)	-15.05 (9.45)	-14.66 (9.41)
Black African	-20.01 (9.11)*	-20.95 (9.11)*	-21.31 (9.10)*
Other (incl. Chinese)	-3.58 (9.50)	-5.37 (9.58)	-4.12 (9.54)
Neighbourhood level			
Rural (ref = urban)		1.38 (2.91)	1.37 (2.88)
Median household income, per £1000		0.52 (0.23)*	0.52 (0.23)*
IMD education domain, per decile (ref=most deprived)		0.78 (0.68)	0.77 (0.69)
School level			
Fees applicable		11.54 (6.37)*	11.63 (6.42)*
Maternal distress (Kessler-6 score)			-1.07 (0.26)***
Constant	314.07 (30.24)	300.61 (30.60)	302.78 (30.57)
Neighbourhood variance	601.83 (134.13)	605.35 (104.32)	599.60 (102.72)
% of total neighbourhood variance explained	27.4	26.9	27.6
School variance	827.45 (117.34)	805.15 (110.34)	808.40 (109.93)
% of total school variance explained	25.5	27.5	27.2
Residual variance	7,137.47 (141.06)	7,128.64 (134.73)	7,117.51 (133.83)
Total unexplained variance	8,566.75	8,539.14	8,525.51
% of unexplained variance due to neighbourhoods	7.0	7.1	7.0
% of unexplained variance due to schools	9.7	9.4	9.5
Bayesian DIC (smaller is better)	111,463	111,445	114,431

*** p < 0.001 ** p < 0.01 *p < 0.05

[1] Covariates include school year and language spoken in the home (data not shown)

Table 8-10 Testing the role of child behaviour and parenting practices - results of cross-classified multilevel models predicting maths test performance (N = 9,412)

	Estimate (Standard Deviation)		
	Model E[1]	**Model F[2]**	**Model G[3]**
Neighbourhood level			
Rural (ref = urban)	1.37 (2.88)	1.53 (2.85)	1.65 (2.86)
Median household income, per £1000	0.52 (0.23)*	0.52 (0.22)*	0.53 (0.22)*
IMD education domain, per decile (ref=most deprived)	0.77 (0.69)	0.53 (0.67)	0.54 (0.68)
School level			
Fees applicable	11.63 (6.42)*	10.57 (6.37)*	11.08 (6.32)*
Maternal psychological distress (Kessler-6 score)	-1.07 (0.26)***	0.04 (0.27)	0.00 (0.27)
Child behaviour (Total Difficulties score)		-2.84 (0.21)***	-2.86 (0.21)***
Parenting practices			
Mother reads daily			-5.40 (1.92)**
No regular bedtime			-0.41 (3.24)
Smacking			1.11 (1.89)
Constant	302.78 (30.57)	341.58 (30.32)	345.41 (30.40)
Neighbourhood variance	599.60 (102.72)	544.32 (105.10)	537.59 (105.72)
% of total neighbourhood variance explained	27.6	34.3	35.1
School variance	808.40 (109.93)	831.67 (109.19)	841.80 (107.02)
% of total school variance explained	27.2	25.1	24.2
Residual variance	7,117.51 (133.83)	6,981.75 (133.42)	6,975.29 (132.17)
Total unexplained variance	8,525.51	8,357.74	8,354.68
% of unexplained variance due to neighbourhoods	7.0	6.5	6.4
% of unexplained variance due to schools	9.5	10.0	10.1
Bayesian DIC (smaller is better)	114,431	111,242	111,238

*** p < 0.001 ** p < 0.01 *p < 0.05

[1] Model E same as in table 9-7 (adjusted also for MCS strata and individual level covariates, data shown in Appendix VIII)

[2] Model F = Model E + mother-reported socio-emotional difficulties

[3] Model G = Model F + parenting practices

8.3.4 Spatial ability

Spatial ability was measured via a pattern construction test. As for reading and maths, the three-level cross-classified model (B) was preferable to the two-level model (A), with the DIC decreasing by 80 (Table 8-11). While Model A ascribes 10.5% of the overall variance in test scores to neighbourhoods, Model B shows that the variance attributable to the neighbourhood level was 6.8%, while 6.3% of the overall variance was due to differences between schools.

Table 8-11 Variability in pattern construction test performance – comparison of two-level and three-level cross-classified variance components models (MCMC estimation, N = 9,412)

	Estimate (Standard Deviation)	
	Two-level model (A)	**Three-level cross-classified model (B)**
Intercept	4.58 (1.15)	4.61 (1.19)
Neighbourhood variance	1,022.40 (115.95)	661.20 (125.74)
School variance	–	606.16 (112.00)
Residual variance	8,678.15 (154.32)	8,415.27 (157.26)
Total variance	9,700.55	9,682.63
% of total variance due to neighbourhoods	**10.5**	**6.8**
% of total variance due to schools	–	**6.3**
Bayesian DIC (smaller is better)	112,843	112,763

After adjusting for family level factors (Model C in Table 8-12), 55% of the initial neighbourhood and 52% of the initial school variance were accounted for. Of the remaining total variance that was not explained by these compositional factors, 3.4% were due to neighbourhoods and 3.3% were due to schools. Living in social housing was again negatively associated with test performance, with the average score being about 13% lower compared to children living in owned or mortgaged accommodation (similar to the maths test). The association with family income appeared to be somewhat weaker than for reading and maths, but the relationship with maternal education was again strong. Maternal age was not independently associated with the outcome. On average, children from all ethnic minority groups scored lower than White children. Children who spoke a second language at home half of the time scored on average 13% higher and children who were in year one scored on average 46% lower in the test (results not shown).

Adding the neighbourhood variables (Model D in Table 8-12) led to a modest improvement in model fit and slight reductions in both the unexplained neighbourhood and school variance. In contrast to the results for reading and maths, the only neighbourhood variable significantly associated with pattern construction test performance was the education domain of the IMD. Average test scores increased by 2% SD per IMD (education) decile. There were no statistically significant differences by schools' fee-paying status. Of the remaining variance, 3.1% was attributed to neighbourhoods and 3.2% to schools.

Testing the role of maternal psychological distress

The improvement in model fit after additionally adjusting for maternal psychological distress was very small and only marginally statistically significant (Model E in Table 8-12). The association between maternal distress and spatial ability was weak. For each point increase in the Kessler-6, the test score was reduced by 0.6% SD. As before, there were no real changes in the fixed effects of any neighbourhood variables, and no suggestion of an important change in the neighbourhood and school variance explained by the model. The conclusion is therefore the same as for reading and maths, that there was no convincing evidence for maternal distress being on the pathway between neighbourhood characteristics and children's spatial ability.

Testing the role of child behaviour

Model F in Table 8-13 shows the same pattern as was demonstrated for the maths test: after additionally adjusting for the Total Difficulties score, the fixed effect for maternal distress was reduced and no longer statistically significant, while the difficulties score itself was negatively and strongly associated with performance in the spatial ability test (approximately -2% SD decrease in the pattern construction score for each point increase in the Total Difficulties score). There was again no evidence of substantial changes in the unexplained school or neighbourhood variance. The full table can be found in Appendix VIII (Table 11-16).

Testing the role of parenting practices

As before, the selected parenting practices did not play an important role (Model G in table 8-13). The total unexplained variance remained almost unchanged, and the improvement in model fit was not statistically significant. Consequently, there was no evidence for mediation.

Table 8-12 Results of cross-classified multilevel models predicting pattern construction test performance (N = 9,412)

	Estimate (Standard Deviation)[1]		
	Model C	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	-10.53 (3.03)***	-5.62 (3.17)*	-5.61 (3.18)*
England – ethnic	-11.23 (5.16)*	-7.13 (5.23)	-7.20 (5.24)
Wales – advantaged	6.88 (5.36)	6.27 (5.44)	6.07 (5.46)
Wales – disadvantaged	-0.95 (4.14)	3.65 (4.31)	3.58 (4.30)
Scotland – advantaged	2.90 (4.63)	3.68 (5.42)	3.45 (5.47)
Scotland – disadvantaged	-10.93 (4.75)*	-5.62 (5.34)	-5.63 (5.33)
NI – advantaged	11.50 (5.56)*	11.74 (6.50)*	11.47 (6.53)*
NI – disadvantaged	-4.64 (4.87)	1.72 (5.54)	1.41 (5.54)
Child and family level			
Girl	6.04 (1.94)**	6.09 (1.93)**	6.01 (1.93)**
Child age in months	0.93 (0.34)**	0.88 (0.34)**	0.89 (0.34)**
Has SEN statement	-50.92 (3.84)***	-50.82 (3.83)***	-50.42 (3.85)***
Weekly family income per £100	1.57 (0.59)**	0.91 (0.61)	0.82 (0.61)
NS-SEC (ref= manag. / prof.)			
Intermediate	-10.96 (3.33)***	-10.24 (3.33)**	-10.24 (3.32)**
Small empl. / self empl.	-6.55 (3.78)*	-5.80 (3.76)	-5.87 (3.76)
Lower supervisory / tech.	-5.60 (4.45)	-4.08 (4.52)	-4.10 (4.51)
Semi routine / routine	-17.28 (3.47)***	-15.54 (3.45)***	-15.49 (3.45)***
No parent in work	-11.28 (3.84)**	-10.56 (3.83)**	-10.00 (3.82)**
Housing tenure (ref= owner)			
Rented privately	-6.67 (4.59)	-6.87 (4.56)	-6.64 (4.52)
Social housing	-12.97 (3.21)***	-11.27 (3.22)***	-11.01 (3.24)***
Other	3.11 (7.29)	2.20 (7.30)	2.27 (7.26)
Maternal age (years)	0.15 (0.19)	0.01 (0.19)	0.02 (0.20)
Maternal NVQ (ref = level 4/5)			
Level 3	-6.38 (3.02)*	-4.96 (3.03)	-4.98 (3.00)*
Level 2	-12.81 (2.68)***	-11.31 (2.70)***	-11.29 (2.70)***
Level 1	-21.10 (4.29)***	-19.27 (4.29)***	-19.32 (4.29)***
Overseas only	-27.27 (7.10)***	-26.60 (7.12)***	-26.32 (7.10)***
None	-32.64 (4.13)***	-30.36 (4.15)***	-30.03 (4.13)***
Number of siblings (ref = none)	-0.77 (1.01)	-0.85 (1.01)	-0.86 (1.01)

Table 8-12 (continued)

	Estimate (Standard Deviation)[1]		
	Model C	**Model D**	**Model E**
Family structure (ref = both natural parents)			
Natural mother / other partner	-1.86 (4.63)	-1.58 (4.61)	-1.29 (4.61)
Single mother	-2.88 (3.03)	-2.96 (3.04)	-2.69 (3.04)
Child ethnicity (ref = White)			
Mixed	-11.61 (6.58)*	-11.83 (6.53)*	-11.60 (6.52)*
Indian	-18.77 (8.14)*	-21.12 (8.21)**	-20.93 (8.22)**
Pakistani	-38.93 (7.86)***	-38.14 (7.81)***	-37.72 (7.86)***
Bangladeshi	-23.46 (11.33)*	-22.26 (11.26)*	-22.17 (11.29)*
Black Caribbean	-53.07 (9.55)***	-54.69 (9.51)***	-54.47 (9.49)***
Black African	-53.17 (9.21)***	-54.02 (9.18)***	-54.21 (9.18)***
Other (incl. Chinese)	-14.08 (9.70)	-16.36 (9.75)*	-15.62 (9.75)
Neighbourhood level			
Rural (ref = urban)		-2.85 (2.69)	-2.87 (2.67)
Median household income, per £1000		0.11 (0.22)	0.10 (0.22)
IMD education domain, per decile (ref=most deprived)		2.32 (0.65)***	2.32 (0.66)***
School level			
Fees applicable		5.25 (6.34)	5.29 (6.38)
Maternal distress (Kessler-6 score)			-0.60 (0.27)*
Constant	-58.34 (30.83)	-62.48 (31.10)	-61.25 (31.10)
Neighbourhood variance	297.24 (92.52)	270.14 (90.82)	265.58 (83.90)
% of total neighbourhood variance explained	55.0	59.1	59.8
School variance	288.85 (89.88)	279.63 (88.05)	291.94 (83.15)
% of total school variance explained	52.3	53.9	51.8
Residual variance	8,156.59 (149.24)	8162.65 (147.64)	8,152.40 (146.06)
Total unexplained variance	8,742.68	8,712.42	8,709.92
% of unexplained variance due to neighbourhoods	3.4	3.1	3.0
% of unexplained variance due to schools	3.3	3.2	3.4
Bayesian DIC (smaller is better)	112,070	112,051	112,047

*** p < 0.001 ** p < 0.01 *p < 0.05

[1] Covariates include school year and language spoken in the home (data not shown)

Table 8-13 Testing the role of child behaviour and parenting practices - results of cross-classified multilevel models predicting pattern construction test performance (N = 9,412)

	Estimate (Standard Deviation)		
	Model E[1]	**Model F**[2]	**Model G**[3]
Neighbourhood level			
Rural (ref = urban)	-2.87 (2.67)	-2.75 (2.65)	-2.69 (2.65)
Median household income, per £1000	0.10 (0.22)	0.11 (0.22)	0.13 (0.22)
IMD education domain, per decile (ref=most deprived)	2.32 (0.66)***	2.12 (0.65)**	2.10 (0.65)**
School level			
Fees applicable	5.29 (6.38)	4.44 (6.36)	4.96 (6.30)
Maternal psychological distress (Kessler-6 score)	-0.60 (0.27)*	0.24 (0.28)	0.23 (0.28)
Child behaviour (Total Difficulties score)		-2.17 (0.21)***	-2.18 (0.21)***
Parenting practices			
Mother reads daily			-5.69 (1.97)**
No regular bedtime			-5.78 (3.35)*
Smacking			1.58 (1.95)
Constant	-61.25 (31.10)	-31.89 (31.03)	-29.32 (31.05)
Neighbourhood variance	265.58 (83.90)	239.20 (91.99)	202.15 (106.51)
% of total neighbourhood variance explained	59.8	63.8	69.4
School variance	291.94 (83.15)	299.79 (90.94)	325.72 (88.35)
% of total school variance explained	51.8	50.4	46.3
Residual variance	8,152.40 (146.06)	8,075.24 (147.31)	8,078.05 (151.30)
Total unexplained variance	8,709.92	8,614.23	8,605.92
% of unexplained variance due to neighbourhoods	3.0	2.8	2.3
% of unexplained variance due to schools	3.4	3.5	3.8
Bayesian DIC (smaller is better)	112,047	111,946	111,942

*** p < 0.001 ** p < 0.01 *p < 0.05

[1] Model E same as in table 9-7 (adjusted also for MCS strata and individual level covariates, data shown in Appendix VIII)

[2] Model F = Model E + mother-reported socio-emotional difficulties

[3] Model G = Model F + parenting practices

8.3.5 Partitioning the variance in cognitive test performance between families, neighbourhoods and schools

The decomposed variances for all three outcomes before and after adjusting for UK country and family characteristics (as estimated in Models B and C) are depicted in Figure 8-4 and Figure 8-5.

Before any adjustments, the percentage of the variance due to differences between neighbourhoods was about 5% for reading, 9% for maths and 7% for spatial ability. The variance due to schools was about 10% for reading, 12% for maths, and about 6% for spatial ability. It makes intuitive sense that the spatial ability test seems less influenced by factors at the school level than reading and maths, as it is not something that is taught explicitly, however schools might differ in their effectiveness to foster this ability. When comparing the two figures it can be seen that for reading and spatial ability, the variances at the neighbourhood and school levels were considerably reduced once compositional effects were accounted for [1]. For reading, the neighbourhood variance was almost completely explained by neighbourhood composition. However, a sizable school effect of about 7% remained. For maths, there was a relatively high contribution of both neighbourhoods and schools (7% and 10% respectively) to test performance even after adjusting for family background characteristics. For pattern construction, the remaining variance attributable to neighbourhoods and schools was about 3% at each level.

As expected, the largest part of the overall variance, between 85% and 95%, was due to differences at the child and family level. As was the case for the socio-emotional outcomes, all variance estimates had however large credibility intervals, so there was considerable variability in how much individual neighbourhoods and schools contributed to children's cognitive development.

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[1] As in the previous chapter, the MCS stratum variable was kept in the adjusted model because of the issue of weighting. Running Model C without the stratum variable produced the following estimates for the variance components: For reading, the variance between neighbourhoods was about 2% and the variance between schools was about 7%; for maths, these were 7% for neighbourhoods and 10% for schools (similar to the model containing the stratum variable); and for spatial ability, the percentages were 3% and 4% respectively.

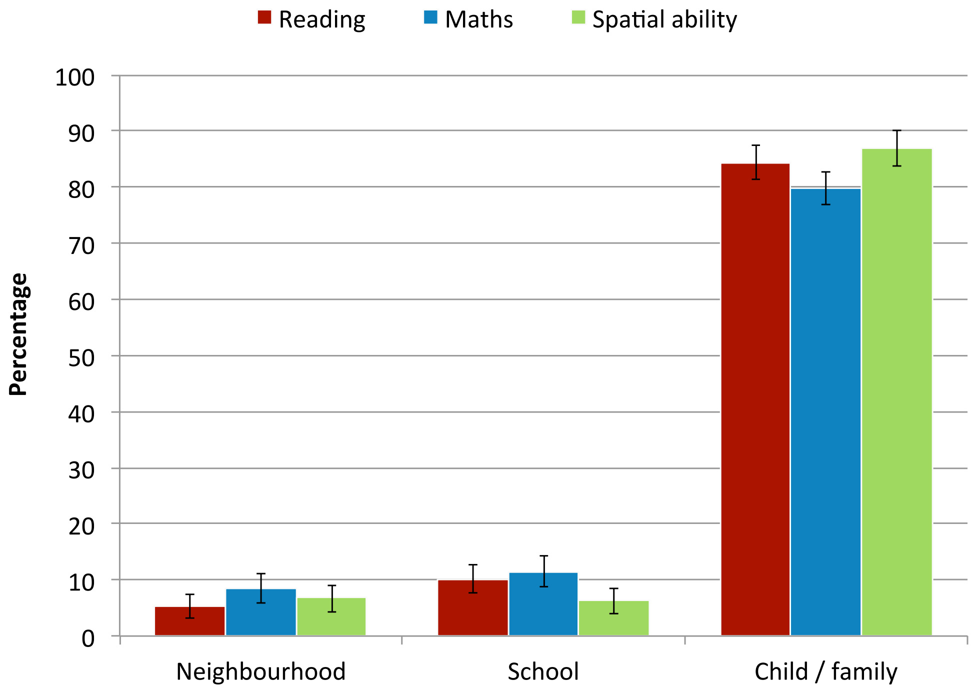

Figure 8-4 Decomposition of unadjusted total variances in cognitive test performance, with credibility intervals

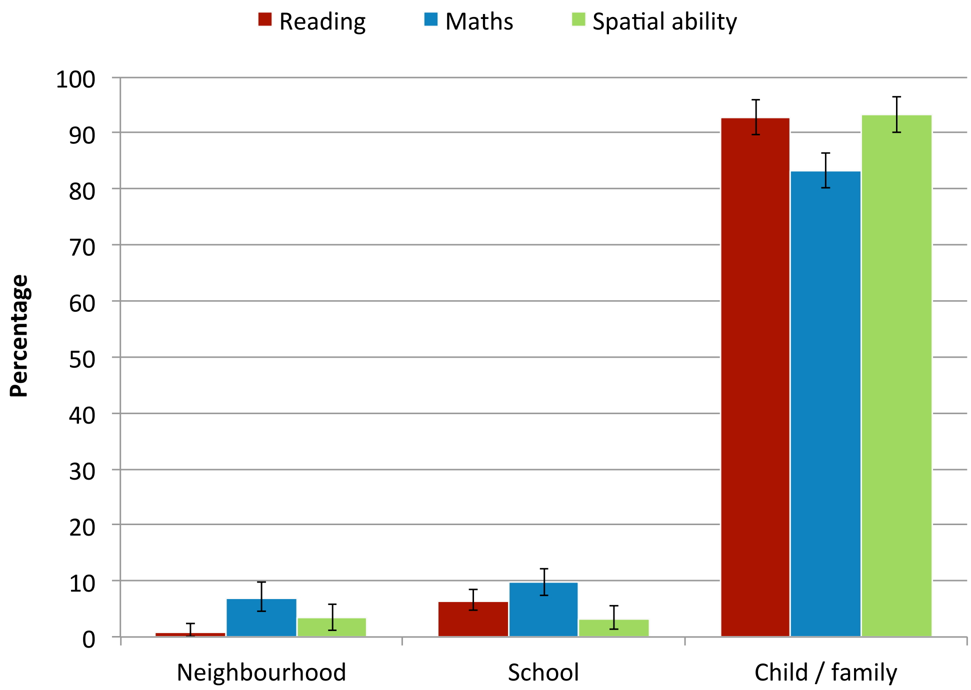

Figure 8-5 Decomposition of variances in cognitive test performance, after adjustment for MCS strata and family socio-economic background[1], with credibility intervals

[1] Adjusted for MCS stratum, child gender, child age, SEN, family income, family NS-SEC, housing tenure, maternal age, maternal NVQ level, number of siblings, family structure, child ethnicity, language spoken at home and school year

8.3.6 Testing for cross-level interactions and complex variation

To test whether the strength of the association between cognitive test scores and median neighbourhood income was the same for children from poor families (defined as living on an income of less than 60% of the median of the population) and children who were not poor, interaction terms were included to fully adjusted two-level models with schools as the higher level.

There was a suggestion that median neighbourhood income was more important for poor children especially for reading, with an average increase in the reading score of 0.76% SD per £1000 increase in median neighbourhood income for non-poor children compared to an average increase of 1.49% SD for children who met the definition of living in relative poverty. The interaction term did however not reach statistical significance (data not shown). For maths, the difference in the coefficients for neighbourhood income was smaller and also not statistically significant (0.56% SD for non-poor versus 0.87% SD for poor children, data not shown). For spatial ability, an interaction between the education domain of the IMD and family relative poverty was tested but was also not found to be statistically significant (data not shown).

Further, it was tested whether there were differences in the amount of between-school variability in cognitive test scores between poor and non-poor children and between boys and girls. There was no evidence for statistically significant differences between poor and non-poor children, however the between-school variability in reading as well as spatial ability test scores was greater for girls than for boys.

Table 8-14 shows the variance components in reading test performance for boys and girls separately, estimated in a model which took the full set of covariates and neighbourhood characteristics into account, except for the parenting practices. Allowing for the complex variation at both the school and the individual level resulted in significantly better model fit compared to the model without complex variation (log likelihood for the model without = 55,335, $p<0.001$). While the overall variability in reading test performance was greater among boys, the between-school variability was greater among girls. The VPC for girls was 11.7, while for boys it was 5.3.

Similarly, the variability in test scores for spatial ability was also greater overall for boys, but again the between-school variability was larger for girls.

It should however be borne in mind that these variances were estimated on two-level models, which took only the school context into account, so these results should be viewed with caution.

Table 8-14 Complex variation in reading test performance

	Estimate (Standard Error)	
	Girls	**Boys**
Between-school variance	777.67 (128.79)	445.38 (140.17)
Residual (within-school) variance	5841.61 (159.49)	7989.93 (206.64)
Total variance	6,619.28	8,435.31
VPC	11.7	5.3
Log likelihood		-55,303

Table 8-15 Complex variation in pattern construction test performance

	Estimate (Standard Error)	
	Girls	**Boys**
Between-school variance	592.52 (140.90)	240.02 (138.44)
Residual (within-school) variance	7371.99 (195.52)	8929.56 (225.31)
Total variance	7,964.51	9,169.58
VPC	7.4	2.6
Log likelihood		-55,954

8.3.7 Summary

Simultaneously partitioning the variance in cognitive test outcomes between neighbourhoods, schools and families has demonstrated that ignoring the school level leads to an underestimation of the role of contextual factors. Two-level models that take only neighbourhoods into account wrongly attribute part of the variance to both the neighbourhood and family levels when it is actually due to schools, an effect that was shown also by Leckie et al. (2010).

Table 8-16 summarises the main results for all three outcomes. The variance decomposition before and after allowing for family background showed that the variability between neighbourhoods and schools was partly due to compositional factors, however differences remained. These were especially large for maths test scores, and overall were more pronounced between schools than between neighbourhoods.

In general, the available neighbourhood and school measures added only little towards explaining the contextual variance. For reading and maths, a statistically significant positive contribution could be demonstrated for median neighbourhood income but not for the education domain of the IMD. In contrast, spatial ability (pattern construction) test scores were significantly associated with the IMD education domain, with children living in less educationally deprived areas scoring higher. Children attending fee-paying schools had a slight advantage regarding the reading and maths tests, after allowing for family socio-economic background.

Another question this section aimed to answer was whether maternal psychological distress was on the pathway between neighbourhood characteristics and children's cognitive test performance. In short, the answer to this question is no. There was no convincing support for a mediating effect of maternal distress, as adding a measure of distress to models that contained both individual level covariates as well as neighbourhood variables did not lead to a reduction in the neighbourhood effects nor to an important reduction in the unexplained variance between neighbourhoods and schools.

While maternal distress was negatively associated with each of the three outcomes, these associations were weak and confounded or mediated by child behaviour, which in turn was strongly related to cognitive test performance. Adjusting for child behaviour did however not result in changes in the unexplained neighbourhood or school variability. This is in line with the findings of the previous chapter, which suggested no important between-neighbourhood or between-school variability in children's socio-emotional difficulties after family characteristics were accounted for.

Table 8-16 Summary table – results of cross-sectional analyses

	Reading			Maths			Pattern construction		
	Model B[1]	**Model C**[2]	**Model D**[3]	**Model B**[1]	**Model C**[2]	**Model D**[3]	**Model B**[1]	**Model C**[2]	**Model D**[3]
% of unexplained variance due to neighbourhoods	**5.4**	**0.7**	**0.6**	**8.6**	**7.0**	**7.1**	**6.8**	**3.4**	**3.1**
% of total neighbourhood variance explained	–	90.2	91.1	–	27.4	26.9	–	55.0	59.1
% of unexplained variance due to schools	**10.2**	**6.5**	**6.1**	**11.5**	**9.7**	**9.4**	**6.3**	**3.3**	**3.2**
% of total school variance explained	–	48.5	52.2	–	25.5	27.5	–	52.3	53.9
Evidence of contextual variables contributing to overall neighbourhood variance?		No			No			Limited	
Evidence of contextual variables contributing to overall school variance?		Limited			Limited			No	
Evidence for indirect association via maternal distress?		No			No			No	
Evidence for indirect association via parenting practices?		No			No			No	

[1] Empty model

[2] Adjusted for MCS strata and individual level covariates

[3] Adjusted for MCS strata, individual level covariates and contextual variables

8.4 Cross-classified multilevel models - longitudinal analysis

8.4.1 Analytical strategy

As with the analyses pertaining to children's socio-emotional development, the cognitive outcomes were examined longitudinally, to see whether maternal neighbourhood perceptions and interviewer-observed neighbourhood disorder measured at sweep two were associated with children's cognitive test performance at age seven, four years later. The analysis sample consisted of 6,524 children with complete information who had lived in the same neighbourhood since sweep two and not changed school. Table 8-17 shows the number of observations per group for the analysis sample.

Table 8-17 Number of LSOAs and schools / observations per group, cognitive test performance longitudinal analysis sample (N= 6,524)

Groups	Number of groups	Observations per group		
		Min	Average	Max
LSOA's	2,916	1	2.2	30
Schools	2,759	1	2.4	22

The same strategy was followed that had been applied for the longitudinal analysis of children's socio-emotional difficulties. For each outcome a set of five models was estimated:

Model A adjusted for MCS strata and individual level covariates. These included: the language spoken at home, the school year the child was in, child gender, child age, SEN status, family income, family social class (NS-SEC), housing tenure, maternal age, maternal education, number of siblings, family structure and child ethnicity.

Model B adjusted for the contextual variables: the rural/urban indicator, neighbourhood median household income, IMD education domain, whether school fees were applicable and the measure of maternal neighbourhood satisfaction reported at sweep two. Model C then additionally adjusted for maternal psychological distress experienced between sweeps two and four.

Model E included the same individual and contextual level measures as Model B, but with interviewer-reported neighbourhood disorder measured at sweep two instead of maternal neighbourhood satisfaction. Model F again adjusted additionally for the cumulative measure of maternal psychological distress.

As before, the tables 8-18 to 8-20 only show the coefficients for the variables of interest, however full tables are provided in Appendix IX (Tables 11-17 to 11-19).

8.4.2 Reading

As was the case in the cross-sectional analysis, the between-neighbourhood variance was small and not statistically significant once child- and family-level covariates were accounted for (Model A in Table 8-18). Median neighbourhood income, but not the education domain of the IMD was associated with reading test performance also in the longitudinal analysis (result for IMD shown in Table 11-17, Appendix IX). There was no clear relationship with maternal neighbourhood satisfaction measured four years earlier: the association was not linear and a statistically significant estimate was found only for the third quintile (Model B in Table 8-18). Maternal psychological distress was not at all independently associated with the outcome, and consequently its inclusion in the model was penalised by an increased DIC statistic (Model C in Table 8-18).

Model D in Table 8-18 shows that there was a weak, nonlinear but statistically significant association with observed neighbourhood disorder. Compared to children living in neighbourhoods that had been rated most favourable by the interviewer at sweep two, children belonging to the third, fourth and fifth quintiles scored on average 7-8% SD lower in the reading test at age seven, after allowing for individual-level covariates. Adding maternal distress to the model made again no difference as the measure was not independently related to the outcome (Model E in Table 8-18).

A separate model was tested which added daily reading to the child and whether the child had a regular bedtime, both measured at sweep two, to the variables in Model E[1]. Children who had been read to daily at age three had on average 14% SD higher reading test scores at age seven than children who had not been read to daily, and children with no regular bedtime at sweep two scored on average 15% SD lower. There was however no important

[1] There was no independent relationship between the reported use of smacking at sweep two and any of the cognitive outcomes at sweep four. The smacking variable was not included in the final models because its inclusion did not add information and would have let to a further drop in sample size.

reduction in the coefficients for interviewer observed neighbourhood disorder or median neighbourhood income, therefore it was concluded that these parenting behaviours were not on the pathway between neighbourhood factors and reading test performance (results not shown).

8.4.3 Maths

The neighbourhood and school variance estimated in Model A were of similar magnitude to what had been found in the cross-sectional analysis (Table 8-19). Again, the IMD education domain was not significantly associated with maths test performance. Model B in Table 8-19 showed that as for reading, the association with maternal neighbourhood satisfaction was statistically significant only for the third quintile. Only current maternal psychological distress was related to the outcome, with children whose mothers reported current distress scoring on average 6% SD lower compared to children whose mothers reported no distress at any of the three sweeps (Model C). The inclusion of maternal psychological distress did however not result in any sizable change of the maternal neighbourhood satisfaction or median neighbourhood income variables.

Model D shows that there was no independent association with interviewer observed neighbourhood disorder, and the inclusion of maternal psychological distress (Model E) was not informative either. While daily reading and regular bedtimes at sweep two (age three) were associated also with higher maths scores at age seven (plus 11% SD for daily reading and plus 7% SD for regular bedtimes), the inclusion of these parenting practices did not attenuate the association with median neighbourhood income.

8.4.4 Spatial ability

Table 8-20 shows the results for spatial ability (pattern construction) test performance. The neighbourhood variance estimated by Model A was similar to the result of the cross-sectional analysis, while the school variance was smaller in this analysis sample. For spatial ability, the IMD education domain but not neighbourhood median income was associated with the outcome (as was the case in the cross-sectional analysis). There was no clear association with maternal neighbourhood satisfaction at sweep two (Model B), and only a weak relationship with persistent maternal psychological distress (Model C). Interviewer observed neighbourhood disorder at sweep two was not associated with the outcome (Model D).

As before, it was concluded that mothers' neighbourhood perceptions and interviewer observations measured at sweep two did not explain variation in later spatial ability test scores, and that there was no evidence for a mediating role of maternal psychological distress. Children who did have a regular bedtime at age three scored on average 13% SD higher on the pattern construction test than children who did not, however there was no evidence for regular bedtime being on the pathway between the IMD education domain and the outcome. Daily reading at sweep two was not significantly associated with pattern construction test performance.

8.4.5 Summary

Apart from a weak association between reading test performance and observed neighbourhood disorder, maternal neighbourhood perceptions and interviewer observations measured four years prior to the cognitive tests had almost no explanatory power.

The measure of maternal psychological distress did not contribute to explaining the variability in reading test scores, and was only weakly associated with maths and pattern construction test performance. The longitudinal analysis supported the conclusions drawn from the cross-sectional models in that there was no evidence to suggest that maternal psychological distress or the examined parenting practices were on the pathway between neighbourhood factors and any of the three cognitive outcomes.

Table 8-18 Results of cross-classified multilevel models predicting reading test performance at age 7, longitudinal analysis (N= 6,524)

	Estimate (Standard Deviation)				
	Model A[1]	**Model B**[2]	**Model C**[2]	**Model D**[2]	**Model E**[2]
Median household income, per £1000		0.80 (0.25)**	0.80 (0.25)***	0.77 (0.25)**	0.77 (0.25)**
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Second		-2.96 (3.31)	-2.79 (3.30)		
Third		-9.28 (3.45)**	-8.99 (3.44)**		
Fourth		0.16 (3.63)	0.51 (3.64)		
Least satisfied		6.07 (4.05)	6.69 (4.08)		
Interviewer observations sweep two (ref = most favourable)					
Second				-0.23 (3.37)	-0.22 (3.36)
Third				-8.48 (3.52)**	-8.37 (3.52)**
Fourth				-7.04 (3.82)*	-6.87 (3.83)*
Least favourable				-8.88 (4.21)*	-8.77 (4.22)*
Maternal psychological distress (ref = none)					
Current (sweep four)			-4.49 (3.12)		-3.88 (3.12)
Past (sweep two and/or sweep three)			0.55 (2.86)		0.98 (2.86)
Persistent (sweeps two, three and four)			-4.16 (3.50)		-3.13 (3.49)
Between neighbourhood variance	45.89 (58.52)^{NS}	25.01 (41.89)^{NS}	40.08 (51.16)^{NS}	24.40 (41.07)^{NS}	39.11 (50.30)^{NS}
Between school variance	501.13 (101.76)	465.45 (97.81)	455.62 (99.23)	466.16 (98.36)	457.22 (99.86)
Residual variance	7,171.36 (153.00)	7,159.78 (151.11)	7,153.44 (152.31)	7,169.96 (151.37)	7,164.14 (152.47)
Bayesian DIC (smaller is better)	76,858	76,821	76,824	76,830	76,833

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ ^{NS} Random effect not statistically significant

[1] Adjusted for MCS strata and individual level covariates.

[2] Also adjusted for MCS strata, individual level covariates, urban/rural indicator, IMD education domain and school fee-paying status.

Table 8-19 Results of cross-classified multilevel models predicting maths test performance at age 7, longitudinal analysis (N= 6,524)

	Estimate (Standard Deviation)				
	Model A[1]	**Model B[2]**	**Model C[2]**	**Model D[2]**	**Model E[2]**
Median household income, per £1000		0.57 (0.28)*	0.57 (0.28)*	0.56 (0.28)*	0.56 (0.28)*
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Second		-1.10 (3.41)	-0.78 (3.41)		
Third		-6.90 (3.56)*	-6.31 (3.56)*		
Fourth		-2.97 (3.75)	-2.28 (3.77)		
Least satisfied		1.33 (4.19)	2.57 (4.21)		
Interviewer observations sweep two (ref = most favourable)					
Second				1.37 (3.47)	1.44 (3.47)
Third				-3.83 (3.64)	-3.54 (3.64)
Fourth				-3.76 (3.98)	-3.29 (3.98)
Least favourable				1.05 (4.40)	1.33 (4.41)
Maternal psychological distress (ref = none)					
Current (sweep four)			-5.67 (3.20)*		-5.50 (3.20)*
Past (sweep two and/or sweep three)			-0.90 (2.94)		-0.82 (2.94)
Persistent (sweeps two, three and four)			-8.94 (3.60)		-8.57 (3.58)
Between neighbourhood variance	678.01 (133.51)	650.63 (131.67)	658.31 (137.96)	650.87 (131.55)	658.39 (137.78)
Between school variance	862.36 (134.90)	855.53 (135.00)	849.56 (132.50)	851.69 (134.85)	845.91 (132.44)
Residual variance	6,887.59 (161.44)	6,889.52 (162.46)	6,881.75 (163.13)	6,894.83 (162.59)	6,887.66 (163.25)
Bayesian DIC (smaller is better)	77,123	77,117	77,114	77,120	77,118

*** p < 0.001 ** p < 0.01 *p < 0.05 [NS] Random effect not statistically significant

[1] Adjusted for MCS strata and individual level covariates.

[2] Also adjusted for MCS strata, individual level covariates, urban/rural indicator, IMD education domain and school fee-paying status.

Table 8-20 Results of cross-classified multilevel models predicting pattern construction test performance at age 7, longitudinal analysis (N= 6,524)

	Estimate (Standard Deviation				
	Model A[1]	**Model B**[2]	**Model C**[2]	**Model D**[2]	**Model E**[2]
IMD education domain, per decile (ref=most deprived)		1.93 (0.78)**	1.93 (0.78)**	2.03 (0.78)**	2.03 (0.78)**
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Second		-4.87 (3.48)	-4.66 (3.48)		
Third		-5.40 (3.63)	-5.01 (3.62)		
Fourth		-7.06 (3.81)*	-6.53 (3.83)*		
Least satisfied		-2.41 (4.26)	-1.38 (4.29)		
Interviewer observations sweep two (ref = most favourable)					
Second				-1.35 (3.54)	-1.21 (3.53)
Third				-4.11 (3.70)	-3.89 (3.70)
Fourth				-6.11 (4.02)	-5.75 (4.03)
Least favourable				0.94 (4.42)	1.23 (4.43)
Maternal psychological distress (ref = none)					
Current (sweep four)			-4.50 (3.29)		-4.48 (3.28)
Past (sweep two and/or sweep three)			-4.34 (3.01)		-4.33 (3.01)
Persistent (sweeps two, three and four)			-6.57 (3.68)*		-6.40 (3.66)*
Between neighbourhood variance	287.19 (119.50)	263.32 (102.60)	281.51 (111.91)	264.10 (102.86)	281.56 (112.04)
Between school variance	198.99 (105.77)	188.09 (97.02)	153.72 (109.53)	193.69 (97.61)	161.71 (109.64)
Residual variance	7,994.17 (175.71)	7,990.27 (179.94)	8,004.16 (181.37)	7,983.99 (179.77)	7,996.33 (181.51)
Bayesian DIC (smaller is better)	77,517	77,501	77,504	77,499	77,503

*** p < 0.001 ** p < 0.01 *p < 0.05 [NS] Random effect not statistically significant

[1] Adjusted for MCS strata and individual level covariates.

[2] Also adjusted for MCS strata, individual level covariates, urban/rural indicator, median neighbourhood income and school fee-paying status.

8.5 Chapter summary

Variability in cognitive test performance between neighbourhoods and schools

Decomposing the variance for the three cognitive tests revealed considerable variability in test scores between schools, especially for reading and maths. The variability in reading scores between neighbourhoods was almost fully explained by neighbourhood composition, while about 7% of the total variance was due to schools. For maths, neighbourhoods contributed about 7% and schools about 10% to the overall variance in test performance even after adjusting for family background characteristics. For spatial ability, the percentage of the overall variance that could be attributed to neighbourhoods and schools was about 3% at each level. Spatial ability test performance was therefore less influenced by factors at the school level than reading and maths. All variance estimates had large credibility intervals, indicating considerable variability in how much individual neighbourhoods and schools affected children's cognitive outcomes.

The findings of this chapter highlight the importance of including both neighbourhoods and schools when aiming to determine the influence of contextual factors on children's cognitive test performance. Inequalities in the examined outcomes were apparent between schools and, to a lesser extent, also between neighbourhoods. These differences were partly due to neighbourhood and school composition, however a sizable proportion of the between-school variance in reading, and both the between-neighbourhood and between-school variance in maths remained unexplained. It can be argued that schools are part of the neighbourhood effect, assuming that the majority of children attend a local school (with the exception of fee-paying schools, which are likely to have wider catchment areas).

Neighbourhood factors associated with children's cognitive test performance

The neighbourhood and school measures that were available at sweep four had small to moderate effects. Both median household income and the education domain of the IMD were associated with cognitive test performance and also explained a small proportion of the school level variance.

The longitudinal analyses examined whether children's cognitive test performance was associated with neighbourhood social processes, measured via maternal neighbourhood satisfaction and interviewer observed neighbourhood disorder. Apart from a weak association between observed neighbourhood disorder and reading test performance, there was only limited evidence for a relationship between these neighbourhood exposures and the cognitive outcomes.

A consistent finding across all three cognitive outcomes was a sizable negative association with living in social housing.

The role of maternal psychological distress and parenting

The data did not support the hypothesis of a mediating role for maternal psychological distress and parenting practices in the relationship between neighbourhood characteristics and children's cognitive test performance.

Maternal distress was negatively associated with all three cognitive outcomes, and the associations appeared to be confounded or mediated by child behaviour. Children's socio-emotional difficulties were found to be strongly related to cognitive test performance. Adjusting for this factor did however not reduce the unexplained neighbourhood or school variability, supporting the results from the previous chapter.

Complex variation by child gender

For both reading and spatial ability, the school context appeared to be more influential for girls than for boys. While the overall variability in these outcomes was greater for boys, the variability in the test scores due to differences between schools was greater for girls.

Chapter 9

Discussion

9 Discussion

9.1 Overview of key findings

The overall aim of this project was to examine whether children's place of residence, their neighbourhood, influenced their socio-emotional and cognitive outcomes at age seven. One central hypothesis was that neighbourhood characteristics affect maternal mental health and parenting practices, which in turn would influence the child outcomes. Another hypothesis was that schools play an important role in explaining inequalities across neighbourhoods in children's social and cognitive development.

Three research aims were formulated, pertaining to:

(1) The extent of neighbourhood influences on levels of maternal psychological distress and parenting practices (chapter six),

(2) The contribution of neighbourhoods and schools to children's socio-emotional development (chapter seven), and

(3) The contribution of neighbourhoods and schools to children's cognitive development (chapter eight).

The use of multilevel models which took the complex data structure into account allowed for the partitioning of the variance in these outcomes between the different contexts (the family, neighbourhoods and schools). It was found that the initial variability in children's socio-emotional difficulties across neighbourhoods and schools was explained once family-level background characteristics were accounted for. However, children's cognitive test performance varied significantly and considerably between neighbourhoods (except for reading) and between schools, even after allowing for compositional effects.

The associations with the available neighbourhood and school measures were modest. It appeared that structural neighbourhood factors such as median household income and the education domain of the Index of Multiple Deprivation were more important for markers of cognitive ability, while measures of maternal neighbourhood satisfaction and observed neighbourhood disorder were more strongly associated with children's socio-emotional development.

The thesis had started out by hypothesising two specific pathways via which neighbourhoods might influence children's socio-emotional and cognitive development. The main findings pertaining to these hypotheses are briefly stated below.

Research hypothesis (1): *Maternal psychological distress and parenting practices are on the pathway between neighbourhood characteristics and children's socio-emotional, as well as cognitive outcomes.*

Overall, the findings revealed that there was limited support for this hypothesis. There was some evidence that maternal psychological distress was on the pathway between social processes in the neighbourhood, measured via mothers' neighbourhood satisfaction and interviewer observed neighbourhood disorder, and mother-reported socio-emotional difficulties. However, the data did not support a mediating role for maternal psychological distress with regards to teacher-reported socio-emotional difficulties or cognitive test performance. The examined parenting practices were not on the pathway between the neighbourhood measures and any marker of socio-emotional and cognitive development.

Research hypothesis (2): *The variability in children's socio-emotional and cognitive outcomes at age seven that can be measured between neighbourhoods is in part due to variability between schools.*

The second hypothesis was supported for both cognitive and socio-emotional outcomes. Two-level models, which only included neighbourhoods as the higher level, underestimated the overall contribution of contextual effects and wrongly attributed part of the variance in the outcomes to both the neighbourhood and family levels, when it was actually due to variability between schools.

The following sections describe the main findings of the three results chapters, with a brief overview given in Table 9-1.

Table 9-1 Summary of main findings

	Maternal psychological distress	Child socio-emotional difficulties		Child cognitive outcomes
		Mother - reported	Teacher-reported	
Statistically significant variability between neighbourhoods after adjusting for individual-level covariates?	No	No	No	Yes, except for reading
Statistically significant variability between schools after adjusting for individual-level covariates?	N/A	No	No	Yes
Neighbourhood structural measures associated with the outcome?	Cross-sectionally only	Yes	Yes	Yes
Maternal neighbourhood satisfaction associated with the outcome?	Yes	Yes	No	No
Interviewer-observed neighbourhood disorder associated with the outcome?	Yes	Yes	Yes	Reading only
Evidence for a mediating role of maternal psychological distress?	N/A	Neighbourhood social processes only	No	No
Evidence for a mediating role of parenting practices?	N/A	No	No	No

9.1.1 Maternal psychological distress and parenting

Chapter six examined whether neighbourhood factors contributed to the variability in levels of maternal psychological distress, as well as to the variability in selected aspects of parenting. Before any adjustments, about 5% of the total variance in maternal distress levels was due to differences between neighbourhoods. This variability was almost completely explained when family-level background characteristics were taken into account. However, mothers' perceptions of their neighbourhood contributed to their experience of psychological distress even after adjusting for baseline distress levels, although the strength of the association was modest.

Both cross-sectionally and longitudinally, there was a clear association between maternal psychological distress and living in social housing. The relationship was attenuated after adjusting for maternal neighbourhood satisfaction, suggesting that living in social housing contributed to negative perceptions of the neighbourhood.

Regarding the parenting behaviours (daily reading, regular bedtime, daily shouting and smacking), significant between-neighbourhood variability after adjustment for family-level covariates was found only for daily reading. Both “daily reading” and “regular bedtime” were independently associated with the degree of neighbourhood deprivation. For “smacking”, there was a suggestion of a relationship with mothers’ neighbourhood perceptions, while “daily shouting” was not associated with any of the neighbourhood variables. None of the relationships between neighbourhood factors and the examined parenting behaviours was mediated by maternal psychological distress.

Maternal psychological distress as well as “daily reading”, “regular bedtime” and “smacking” were included in subsequent analyses as potential mediators in the relationships between neighbourhood characteristics and the markers of child socio-emotional and cognitive development.

9.1.2 Socio-emotional development

Chapter seven examined neighbourhood influences on children’s socio-emotional development, measured via the Total Difficulties score of the SDQ, which had been reported by mothers as well as teachers. The correlation between mothers’ and teachers’ ratings was only moderate, meaning that they did not necessarily identify the same children as having emotional or behavioural difficulties.

The cross-sectional analysis showed that before any adjustments, about 4% of the variability in mother-reported Total Difficulties scores was between neighbourhoods, and about 6% was between schools. At both levels, this variability was explained after accounting for individual level background characteristics. For the teacher-reported scores, differences between neighbourhoods and schools accounted for about 3% of the unadjusted variability at each neighbourhood and school level, and again this was explained after allowing for the individual-level covariates. However, even after these adjustments, there remained a sizable unexplained variability of about 12% in the teacher-reported outcome between the teachers themselves. Substantial between-teacher variability in the rating of children’s social behaviours has been reported before (Mashburn et al., 2006), but was not further investigated here.

There was a suggestion that the neighbourhood context was more influential for the socio-emotional development of children who were living in relative poverty. For these children, significant between-neighbourhood variability in mother-reported socio-emotional difficulties was found even in the fully adjusted model. Further, there was a statistically significant interaction between neighbourhood median income and family-level relative poverty: Neighbourhood median income was associated with mother-reported difficulties only among children from families living in relative poverty, but not among children whose families were not poor.

Cross-sectionally, the percentage of social housing in the neighbourhood was weakly associated with both mother- and teacher-reported Total Difficulties scores. In the longitudinal analyses, associations between the proportion of social housing and markers of socio-emotional development were slightly attenuated after adjusting for maternal neighbourhood satisfaction and observed neighbourhood disorder, suggesting that the proportion of social housing and social processes in the neighbourhood are related. A possible explanation is that a high proportion of social housing means that residential mobility is also high, resulting in less cohesive neighbourhoods (Burrows, 1999). Children whose mothers reported to have neither friends nor family in the area also did worse on both outcome measures. Maternal psychological distress was strongly associated with mother-reported socio-emotional difficulties, and also, but to a lesser degree, with the teacher-reported outcome. However, the cross-sectional analyses provided no evidence to suggest that maternal psychological distress was on the pathway between characteristics of the neighbourhood and either outcome.

The longitudinal analyses showed that mothers who were less satisfied with their neighbourhood when their children were three years of age reported on average more socio-emotional difficulties for their child when aged seven. This association was attenuated after adjusting for maternal psychological distress throughout the early childhood years i.e. from age three to seven. No association was found between maternal neighbourhood satisfaction and the teacher-reported scores. Interviewer observed neighbourhood disorder, also measured when cohort members were three years of age, predicted both mother- and teacher-reported socio-emotional difficulties at age seven, but only the association with the mother-reported outcome was attenuated after adjusting for maternal psychological distress through the early childhood years.

None of the examined parenting practices (daily reading, regular bedtime and smacking) was found to be on the pathway between the neighbourhood factors (or maternal psychological distress) and either mother- or teacher-reported socio-emotional difficulties.

Of note is that mother- as well as teacher-reported socio-emotional difficulties were positively associated with living in social housing in both the cross-sectional and longitudinal analyses. The association was stronger for the mother-reported outcome. Adjusting for maternal psychological distress attenuated the relationship with mother-reported scores, but not with difficulties as reported by the teacher.

9.1.3 Cognitive development

The aim of chapter eight was to examine the contribution of neighbourhoods and schools to children's cognitive test performance in reading, maths and spatial ability. It could be shown that the inclusion of schools as a level of influence was important for the estimation of the variability in these cognitive outcomes, and that its omission would have led to an underestimation of contextual influences.

At age seven, the percentage of the unadjusted variance in cognitive test performance between neighbourhoods was about 5% for reading, 9% for maths and 7% for the spatial ability test. The unadjusted variance between schools was about 10% for reading, 12% for maths, and 6% for spatial ability. After allowing for family background characteristics, the neighbourhood variance for reading was no longer statistically significant, while a school effect of about 7% remained. For maths, the remaining variance attributable to neighbourhoods and schools was 7% and 10% respectively, while for spatial ability, this was about 3% at both levels.

Reading and maths test performance were independently associated with neighbourhood median household income, and spatial ability scores with the IMD education domain in the expected directions. There was little evidence for important associations with neighbourhood social processes.

Maternal psychological distress did not appear to play an important role for children's cognitive test performance. Across the three tests, the relationships with maternal distress were weak and appeared to be driven mainly by associations between maternal distress and child behaviour. There was no evidence for a mediating role of either maternal psychological distress or parenting behaviours.

Again, a consistent finding across all three cognitive tests was a negative relationship with living in social housing, however these associations were not substantially attenuated after adjusting for maternal psychological distress or parenting practices.

9.2 The role of maternal psychological distress in the relationships between neighbourhood characteristics and child outcomes

One research hypothesis was that maternal psychological distress is on the pathway between neighbourhood factors and child outcomes. This section links and interprets the findings from the three results chapters regarding the role of maternal distress.

The associations between maternal psychological distress, neighbourhood social processes and child socio-emotional and cognitive outcomes that had empirical support are depicted in Figure 9-1. Both maternal neighbourhood satisfaction and interviewer observed neighbourhood disorder independently predicted maternal psychological distress, although the associations were modest. The relationship between mothers' experience of psychological distress and their satisfaction with the neighbourhood appeared to be bidirectional.

Results regarding the role of maternal psychological distress in the relationship between neighbourhood factors and children's socio-emotional outcomes were somewhat mixed. Maternal distress was related to both mother- and teacher reported socio-emotional difficulties, however the association with teacher reported scores was much weaker. Maternal neighbourhood satisfaction was associated with mother-reported but not teacher-reported socio-emotional difficulties, whereas observed neighbourhood disorder was related to the reports of both informants.

The longitudinal analyses showed that mothers' neighbourhood perceptions were associated with both their experience of psychological distress and their reports of socio-emotional difficulties in the child. The association between maternal neighbourhood satisfaction and mother-reported socio-emotional difficulties was clearly attenuated after adjusting for maternal psychological distress through the early childhood years. This might have been partly due to confounding or same-source bias, as distressed mothers might have been more likely to report a bleaker picture of their neighbourhood, while at the same time experiencing more difficulties in the relationship with their child.

But, there was also evidence that maternal distress was on the pathway between observed neighbourhood disorder and mother-reported socio-emotional difficulties. As these were interviewer observations, the attenuation of the relationship could not be caused by same-source bias, instead supporting the hypothesis of mediation. Neighbourhood disorder and perceived lack of safety appears to affect the mother-child relationship via increasing levels of maternal distress.

A mediating role for maternal psychological distress could however be ruled out for the relationship between interviewer observed neighbourhood disorder and teacher-reported socio-emotional difficulties, which might be explained by the generally weak association between maternal psychological distress and teacher-reported scores.

As stated above, the associations between maternal psychological distress and children's cognitive outcomes were found to be weak, and were either confounded or mediated by child behaviour.

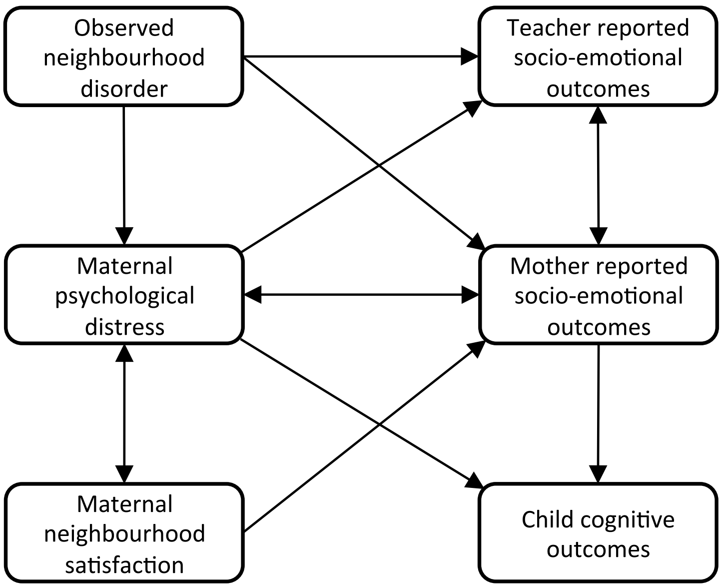

Figure 9-1 Associations between maternal psychological distress, neighbourhood social processes and child socio-emotional and cognitive outcomes

9.3 The role of neighbourhoods and schools

The results for the child outcomes highlight the importance of including both neighbourhoods and schools when aiming to determine the contribution of contextual factors to children's socio-emotional and cognitive development. Partitioning the variance in these outcomes after allowing for family-level covariates showed that for socio-emotional development, the variability between neighbourhoods and schools was explained by compositional effects, while significant and sizable variability was observed between neighbourhoods and schools for children's cognitive test performance over and above neighbourhood and school composition.

Even though there was no statistically significant between-neighbourhood variability in children's socio-emotional outcomes after adjusting for compositional effects, there were still independent associations with the percentage of social housing in the neighbourhood, maternal neighbourhood satisfaction and observed neighbourhood disorder. This is a common phenomenon in multilevel studies, and one possible reason for such findings is the problem of defining neighbourhoods (Weich, 2005; Diez-Roux, 2007). While the spatial scale chosen for the present research is one of its strengths, it is still based on administrative boundaries. It can be argued that for people living at the edges of such boundaries, their sense of neighbourhood overlaps with adjacent areas, and further, that people will be using the facilities and amenities of neighbouring areas too. By the same reasoning, low Variance Partition Coefficients, while indicative of the size of differences between neighbourhoods, do not mean that there are no relevant neighbourhood effects (Diez-Roux, 2007).

For schools however, the above arguments do not apply, as schools are clearly defined entities. Between-school variances are therefore, arguably, easier to interpret. The between-school variability in reading and maths test performance found in this study was substantial, and was only partly explained by the clustering of children from similar socio-economic backgrounds. Educational research from the UK has shown that teaching quality influences children's progress in cognitive development during the primary school years, independent of their family background (Sparkes, 1999; Sammons et al., 2008). The quality and effectiveness of the learning environment provided by schools can be thought of as part of the neighbourhood effect, given that most children will attend local schools and place of residence will thus determine the choices they have (as stated earlier, this might not apply to fee-paying schools, however these are only a small percentage of all schools). Many column inches have been written about middle-class parents going to great lengths to get their children into the "right" school, and recent research has shown that in England, house prices are indeed linked to the quality of local schools as measured via league tables (Gibbons, Machin and Silva, 2012). This means that places in schools which are well regarded are likely to be disproportionately allocated to the better-off who can afford to move into close proximity to the desired school, leading to segregation effects and perpetuating inequalities. Such mechanisms might explain the observed associations between cognitive outcomes and neighbourhood affluence.

It was noted that the results regarding the between-neighbourhood and between-school variance differed across the three cognitive tests. The variability in maths was high at both levels, and was explained only to a relatively small extent by family background. In contrast, family background characteristics almost fully explained the between-neighbourhood variance in reading and more of the between-school variance compared to maths. An earlier UK study on Key Stage 1 attainment in a sample of children from London schools also found that the between-school variability was higher for maths compared to reading (Sammons, West and Hind, 1997). A possible explanation is that reading is an activity that is more actively practised and encouraged by parents compared to maths, while the extent to which parents engage in reading activities is socially graded, as shown in chapter six and also by previous research (Kelly et al., 2011b). The finding that schools mattered less for spatial ability than for reading and maths also makes intuitive sense, as this ability is not explicitly taught in schools. Overall, schools appeared to be more important for children's cognitive development than neighbourhoods, a finding that has been reported also by Leckie (2009) and Rasbash et al. (2010).

Thoughts on the context/composition dilemma

The context/composition debate revolves around the question whether differences that can be observed between neighbourhoods are merely due to selection, and, if there were independent contextual effects, which variables should be controlled for in order to separate selection effects from "true" neighbourhood effects. An alternative view is that the distinction between context and composition is unhelpful because of reciprocal relationships between people and places (Cummins et al., 2007), and that factors such as education and social class, which are usually controlled for, are not independent from area effects (Subramanian, 2004).

However, not controlling for individual-level socio-demographic background variables is not an option either. Although the unadjusted variability in a given outcome between neighbourhoods (or schools) is informative and important in itself, neighbourhood research is interested in whether outcomes for the same people would be different were they living in a different environment. In this thesis, the covariates included in the analyses were chosen carefully and a priori based on findings from previous research, and were assumed not to obscure the hypothesised pathways. It is however acknowledged that the models that were fitted here might have been over-adjusted for individual-level factors, in which case the variability in the outcomes between neighbourhoods and schools was underestimated. The question of the "ideal selection model" (Subramanian, 2004), a model which adequately adjusts for exactly the right covariates, remains one of the unresolved problems in neighbourhood research.

The situation is complicated further by the recognition that neighbourhood characteristics might not affect everyone equally, but that such effects might depend on characteristics of the individual such as gender or socio-economic background. The results of the present research indeed suggested that the variability between neighbourhoods and schools in child outcomes was dependent on child and family characteristics (neighbourhood median income mattered only for poorer children's socio-emotional development, while the between-school variability in cognitive outcomes was greater for girls). These findings underline that these are complex relationships which are not easily generalisable.

9.4 The role of social housing

A consistent finding throughout this thesis was the association between living in social housing and poorer maternal and child outcomes, after allowing for a range of family background characteristics. In both cross-sectional and longitudinal analyses, mothers living in social housing reported on average more psychological distress. Their children had on average more socio-emotional difficulties, and this was true for both mother and teacher reports. Living in social housing was also associated with lower scores on all three cognitive tests. Across all outcomes, the relationships with social housing were slightly attenuated after adjusting for neighbourhood characteristics, suggesting that the neighbourhood environment surrounding the average social housing accommodation contributed to these associations. It should be reiterated that the parenting behaviours that were included in the analyses did not explain the associations between living in social housing and the child outcomes.

The link between social housing and poorer outcomes regarding health and life chances (such as employment) in the UK is well known and has been investigated previously (Ellaway and Macintyre, 1998; Macintyre et al., 2003; Feinstein et al., 2008). There are three possible explanations, which are not mutually exclusive. It might be that living in social housing is a "proxy" for other, unmeasured factors that disproportionately affect these families. Another explanation is that people living in social housing are typically faced with multiple problems, and that it is this cumulative disadvantage which drives the consistent associations with poorer outcomes. Or, there might be issues regarding the quality and features of social housing itself.

The first explanation seems unlikely, because social housing has been repeatedly linked to poorer outcomes across different domains such as mortality, physical health, mental health and life chances such as adult worklessness, while studies have adjusted for a wide range of different potential covariates (Chandola, 2000; Macintyre et al., 2003; Feinstein et al., 2008).

There is however evidence in support of the second explanation. Feinstein et al. (2008) investigated the role of social housing on life chances[1] using data from four UK cohort studies. Their report also describes the historical development of social housing provision in the UK. The analyses showed that for the 1946 cohort, growing up in social housing was not associated with worse life chances. The links between social housing and poorer outcomes emerged mainly from the 1970s onwards. Historically, there have been major shifts regarding access to and quality of social housing. Since the Second World War, the percentage of owner/occupiers has risen steadily, while social housing increasingly became the option for the most and often multiply disadvantaged. This development was arguably amplified by the right-to-buy scheme, which led to better-quality housing being bought by tenants, thus leaving a shrunken social housing stock of overall poorer quality. Nowadays, waiting lists and eligibility criteria mean that families in social housing are more likely to be affected by multiple disadvantage (Feinstein et al., 2008). In turn, multiple disadvantage is a strong predictor for poorer child outcomes, which has been shown recently on MCS data (Bartley, 2012; Sabates and Dex, 2012).

There is also some support in the literature for the third explanation, that problems detrimental to mental and physical health and well-being are disproportionately found in social housing, such as damp, noise, poor state of repair, overcrowding and area problems (Ellaway and Macintyre, 1998; Macintyre et al., 2003). Such problems might add to the disadvantages which made tenants eligible for social housing in the first place.

[1] "Life chances" were measured via an indicator of multiple disadvantage, defined as the experience of more than one of the following negative adult outcomes: worklessness, being in a workless household with children, financial problems, depression, permanent sickness/disability, smoking and single parenthood.

9.5 Comparisons with previous research

9.5.1 Comparing studies on maternal psychological distress and parenting

The results from chapter six regarding neighbourhood influences on maternal psychological distress were in line with previous research, which consistently found independent associations between maternal psychological distress or symptoms of depression and mothers' perceptions of neighbourhood safety and disorder, as well as with interviewer ratings of the neighbourhood (e.g. Christie-Mizell et al., 2003; Barnes et al., 2010).

Regarding neighbourhood influences on parenting behaviours, it was found here that reading to the child, a marker of the home learning environment, was associated with neighbourhood deprivation, but that the relationship was not mediated via maternal psychological distress. Similar associations had been reported by Greenman et al. (2011) and Klebanov et al. (1994), while Frech and Kimbro (2011) did not find a relationship between neighbourhood disadvantage and parenting activities. Mediation via maternal depression was equally not supported in any of the above studies.

The finding that mothers' neighbourhood satisfaction (which included her sense of safety in the neighbourhood) was associated with the use of smacking is consistent with what had been concluded by the review of Leventhal and Brooks-Gunn (2000), but contrasts with the results of two later studies which did not find associations between perceived danger and harsher parenting (Pinderhughes et al., 2001; Ceballo and McLoyd, 2002). However, the association found here between maternal neighbourhood satisfaction and smacking was not linear and should therefore not be over interpreted.

9.5.2 Comparing studies on socio-emotional development

The results from this thesis suggest that for children's socio-emotional development, neighbourhood social processes were more important than measures of structural advantage or disadvantage. The present findings regarding the associations between maternal neighbourhood satisfaction and observed neighbourhood disorder on the one hand, and children's socio-emotional difficulties on the other, are in support of the majority of previous research (e.g. Xue et al., 2005; Barnes and Cheng, 2006; Lima et al., 2010; Singh and Ghandour, 2012).

Most earlier studies which had examined measures of neighbourhood deprivation reported links with children's emotional and behavioural outcomes. Here, a (weak) association was found between the percentage of social housing in the neighbourhood, which is a measure of disadvantage, and children's socio-emotional difficulties. Neighbourhood affluence however, measured via median neighbourhood income, was independently related to children's socio-emotional difficulties only among children from families living in relative poverty, and only for difficulties reported by the mother. This is in contrast to some earlier studies from the US and Canada which had reported an overall beneficial effect of neighbourhood affluence (Shumow et al., 1998; Kohen et al., 2002; López Turley, 2003), although it should be mentioned that the studies by Shumow et al. (1998) and López Turley (2003) were among older children. It might be that such associations become more apparent once children spend more time in the neighbourhood unsupervised.

The between-neighbourhood variability in children's behavioural difficulties varied widely among studies, with unadjusted ICC's reported between 2% and 11%. To my knowledge, no study has so far simultaneously assessed the between-neighbourhood and between-school variability in children's socio-emotional outcomes. The here presented estimates for the unadjusted between-neighbourhood and between-school variance were about 4% and 6% respectively, most of which was due to compositional effects.

Mediation via maternal mental health and parenting

The present results were consistent with the hypothesis that maternal psychological distress played a role in the relationship between neighbourhood disorder and mother-reported socio-emotional difficulties. Previous findings regarding a mediating relationship via maternal mental health had been mixed. Two studies reported mediation via maternal depression for a mother-reported exposure. Using Australian data, Sanson et al. (2011) found evidence for mediation in the relationship between mothers' subjective perceptions of neighbourhood belonging and socio-emotional adjustment measured via the SDQ, and a small US study by Greenberg et al. (1999) reported that the association between perceived safety and problem behaviour was mediated by maternal depression. In contrast, two UK studies found no evidence for a mediating effect of maternal depression (Barnes and Cheng, 2006; McCulloch, 2006).

This research did not find evidence for mediation via parenting practices, which is in contrast to the results of three earlier studies (Kohen et al., 2008; Sanson et al., 2011;

Odgers et al., 2012). Odgers et al. (2012) had analysed UK data, but their outcome variable was antisocial behaviour, which might explain the different pathways and conclusions. It is also possible that the null-findings of the present research are due to the broad range of family-level background characteristics that were included as covariates. Such comprehensive measures of family-level socio-economic position (SEP) were not available to most previous studies.

Studies using MCS data

Flouri et al. (2009) analysed MCS data to examine the associations between neighbourhood deprivation and children's socio-emotional difficulties. The study included MCS cohort children at three years of age and their older siblings, and treated families as an additional level. Neighbourhoods were also defined at LSOA level. The ICC was reported for a three-level model which adjusted for the MCS design strata, child's age and sex and biological relatedness between cohort children, siblings and parents. In this model, 2.5% of the overall variability in the outcome was between areas. Area multiple deprivation was not independently associated with socio-emotional difficulties after adjusting for family level socio-economic position.

In a later study, Flouri et al. (2012) examined the different domains that make up the SDQ Total Difficulties score separately, and reported that when the children were three years old, neighbourhood deprivation was independently associated with peer problems and internalising problems, with the latter association being mediated by maternal mental health. No independent association was found between externalising problems and neighbourhood deprivation. The ICC for Total Difficulties among the three-year-olds, adjusted for MCS design strata, was 3.3% (Flouri et al., 2012).

The results of the present research are consistent with these findings, although they are not directly comparable because of the different samples, outcomes and methodologies. This study adds to the research by Flouri et al. (2009) and Flouri et al. (2012) in that the outcomes were measured at age seven and included teacher-reported socio-emotional difficulties, and most importantly that both neighbourhoods and schools were simultaneously included as contextual levels of influence. The present study took a longitudinal perspective by analysing data for children who had been residentially stable for several years. Further, this research considered maternal neighbourhood satisfaction and observed neighbourhood disorder as exposure variables, as well as a measure of neighbourhood-level social housing derived from census data, all of which were shown to be associated with child socio-emotional difficulties.

9.5.3 Comparing studies on cognitive development

There is a wealth of research showing a positive relationship between neighbourhood affluence and children's cognitive outcomes. This study produced similar findings for reading and maths test performance, therefore confidence in the overall association seems warranted.

So far, few studies have investigated relationships between cognitive outcomes and neighbourhood social processes. The present study found no convincing evidence for associations between maternal neighbourhood satisfaction and children's cognitive test performance, which is consistent with Greenberg et al. (1999) as well as Sanson et al. (2011). Similar to the findings reported by Kohen et al. (2002), observed neighbourhood disorder was related to average reading scores in the longitudinal analysis sample. The association was however weak and not linear, therefore this result should not be overstated.

The finding of greater between-school variability for children's cognitive outcomes compared to the variability between neighbourhoods is consistent with the conclusions drawn in previous UK studies on GCSE results (Leckie, 2009; Rasbash et al., 2010). The suggestion that schools mattered more than neighbourhoods with regards to cognitive development also supports the findings from the US "Harlem Children's Zone" experiment, which had highlighted the potential of high-quality schools in closing the Black-White achievement gap (Dobbie and Fryer, 2011). Another US study which showed the importance of school characteristics for children's reading competence is the research by Dupere et al. (2010), although this study had not estimated between-school variability.

Mediation via maternal mental health and parenting

In line with the present findings, mediation via maternal mental health was not supported by any of the earlier studies which had been reviewed here. However, previous research is very mixed with regards to mediation via parenting practices and the home environment. Given these discrepancies, it is difficult to draw any conclusions, however the existence of such diverse findings might point towards spurious associations.

9.5.4 Summary of pathways supported by the present findings

Figure 9-2 is a revised version of the conceptual model shown in chapter three, section 3.2, and depicts the pathways that were supported by the results of this thesis.

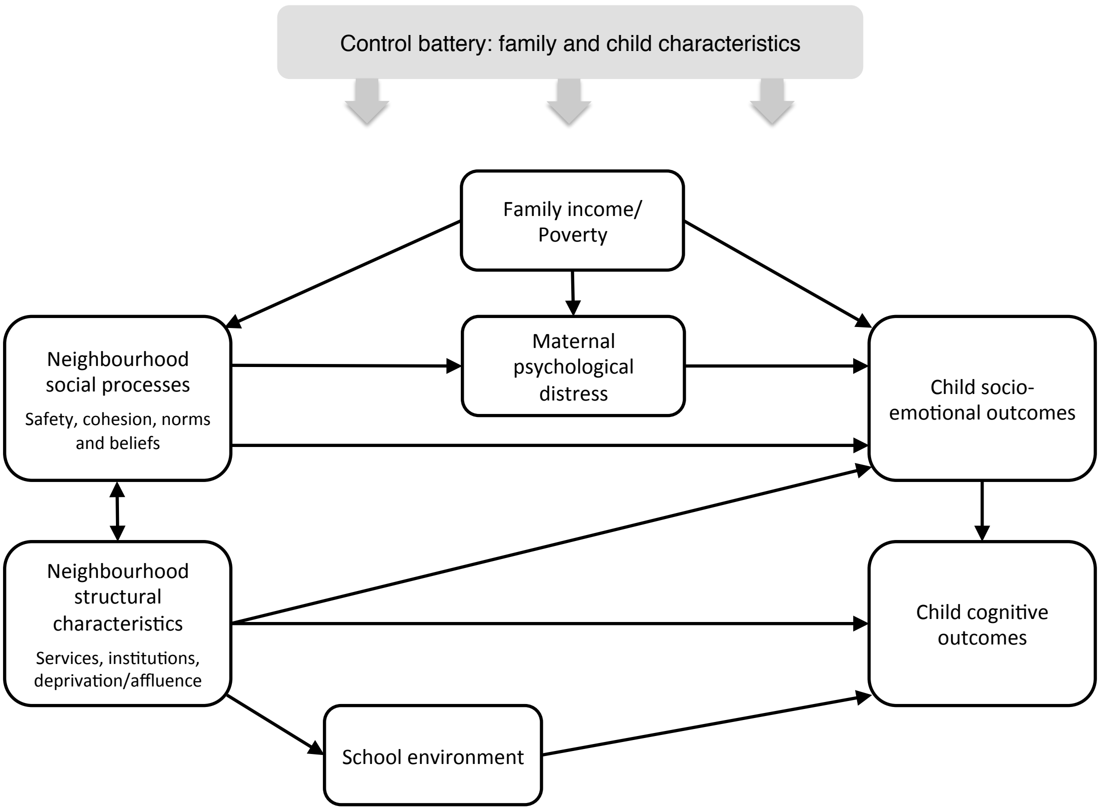

Figure 9-2 Conceptual model revised – pathways supported by the present research

Considering the findings of earlier research and the results from this analysis together, the pathways that have good empirical support are the following:

1. For children's socio-emotional development, a pathway via neighbourhood social processes, and possibly via maternal psychological distress.
2. For children's cognitive development, a pathway via institutional resources, that is, via factors operating at the school level.

To summarise, differences between neighbourhoods and schools were more pronounced for markers of cognitive development, and the pathways at play appeared to differ from those for socio-emotional outcomes.

9.6 Strengths and limitations

9.6.1 Strengths

With the Millennium Cohort Study, the analysis was based on data from a large, nationally representative sample, which is geographically clustered and contains a wealth of information, including different validated measures of early child development and factors potentially influencing these outcomes. A particular advantage was the availability of a very good range of detailed family background characteristics, which are needed to be confident that potential neighbourhood effects are not merely due to neighbourhood composition. Also, place effects are unlikely to be instantaneous. The prospective design of the MCS made it possible to examine the influence of earlier exposures on the child outcomes, such as maternal psychological distress over time and parenting practices reported at an earlier age, for children who had been residentially stable over several years.

The main strength of this research was the use of a statistical method which allowed the simultaneous modelling of between-neighbourhood and between-school variability in the examined child outcomes. In addition, the between-teacher variance in teacher-reported socio-emotional difficulties was also modelled, which proved important given the large variability between teachers which would have been wrongly attributed to schools. Until now, there are only a few studies on UK data which have partitioned the variance in children's cognitive outcomes between neighbourhoods and schools (Fielding et al., 2006; Leckie, 2009; Rasbash et al., 2010). To my knowledge, the simultaneous modelling of between-neighbourhood and between-school differences in children's socio-emotional outcomes has not been carried out before, and so far no studies have estimated cross-classified models using MCS data.

The present analyses exploited the fact that the MCS contains information from different informants, i.e. interviewer observations of the neighbourhood and teacher reports of children's socio-emotional difficulties. Thus, associations could be compared across the different sources of information. The availability of interviewer observations of the neighbourhood environment in the MCS is an advantage to be highlighted also because it is a true contextual measure, which is not based on aggregated characteristics of individuals as census measures are.

Defining "neighbourhood" in a meaningful way remains one of the challenges in neighbourhood research. A further strength of the data and analysis was the definition of neighbourhoods at the small area level. The chosen boundaries – LSOAs for England and Wales, Data Zones for Scotland and Super Output Areas for Northern Ireland – are designed to comprise socially homogeneous areas and can reasonably be assumed to have a similar meaning on the ground in the four UK countries. Although these are still administrative boundaries, they appear to be useful approximations for the concept of "neighbourhood".

Because the data were analysed cross-sectionally and longitudinally, results could be compared across different analysis samples, increasing the confidence in consistent findings.

9.6.2 Limitations

The analyses had of course also several limitations that need to be acknowledged. A main drawback was the lack of measures at the school level. While the availability of school identifiers allowed for the modelling of between-school variability, it could not be investigated which school characteristics were responsible for the differences between schools.

Restricting the cross-sectional analysis samples to families who had lived in the same area since the previous sweep (i.e. for at least 2 years) was an attempt to reduce measurement error arising from families moving. However, any chosen cut-point is inherently arbitrary, and the analyses ignored neighbourhoods lived in previously. Restricting the samples to residentially stable families also meant that families who were more disadvantaged were disproportionately lost to the analyses. Ideally, multiple membership models would be estimated, where each neighbourhood is given a weight corresponding to the length of time a family had lived there. However, this approach was beyond what was possible within the scope of this project, and would have required information on all addresses lived at between sweeps, which was not available.

While the neighbourhood definition that was employed is seen as a strength, it is still based on administrative boundaries. As mentioned earlier, static boundaries are always somewhat problematic because residents' perceptions of what constitutes their neighbourhood are likely to shift within an area. Also, the characteristics of adjacent areas could not be modelled here but might be important as well. Further, neighbourhood effects might operate at different spatial scales depending on the exposure of interest. For example, feelings of safety might relate to smaller boundaries than school catchment areas.

In section 4.9.2, it was shown that mothers and children for whom data was missing tended to be more disadvantaged and had on average poorer outcomes. Disadvantaged families are also more likely to be lost due to attrition. Assuming that children from more disadvantaged families who were not included in the analyses because of missing data would have contributed more extreme values, the reported estimates of the variability in the outcomes are likely to be conservative.

9.6.3 Recommendations for future research

The main finding of this project was that marked differences between schools regarding children's cognitive development exist already at an early age. What could not be investigated were school-level factors that might explain these differences. This appears to be an important area for further research. It is possible for example to link Ofsted data on school performance, which are available for schools in England, into the MCS dataset. Some work on this has already been done, and found that overall Ofsted ratings were related to children's attainment at Key Stage 1 (George, Stokes and Wilkinson, 2012).

As the MCS children get older, they are increasingly providing their own views to the study. This opens an exciting opportunity to gain valuable insights regarding how the children themselves feel about their neighbourhood and their school, and further, whether their reported attitudes and behaviours cluster within areas. It is also possible that the influence of neighbourhood and school level factors increases with the age of the child, a hypothesis that has been formulated by previous studies and could be tested using data from the forthcoming sweeps.

The consistent finding of social housing at the family level being associated with poorer outcomes should be investigated further. Possible routes for research are whether the relationships with social housing are still becoming stronger as the MCS children get older, and whether it is indeed multiple disadvantage that provides an explanation for these associations.

Another finding from this project that merits attention is the teacher variability in the assessment of children's socio-emotional difficulties. While it might be expected that there is considerable variation in what teachers perceive as difficult behaviour, it might be that such variability has important implications for children's educational outcomes.

Given that observational studies allow only limited causal inference, an important field of research are community trials or evaluation studies of existing area or school-based programmes.

9.7 Policy implications

One policy issue that arises from neighbourhood research is whether disadvantage should be targeted at the area level via Area Based Initiatives (ABI) or whether support should be provided to individuals (Joshi et al., 2000; Dorling et al., 2001). The criticism levelled at neighbourhood research – that severely disadvantaged places are not at the root but a symptom of an unequal society – is to be taken seriously. It is unlikely that the existing inequalities in children's socio-emotional and cognitive development, which are substantial, can be solved at the small area level. This research has shown that several factors contribute to children's experience of disadvantage. These include first and foremost markers of family socio-economic position, i.e. income, maternal education and parental social class, but also housing, schools, and the neighbourhood environment. An integrated approach is needed which supports children and their families at all these levels, with measures that lift children out of poverty clearly being among the most important.

The here presented results have highlighted the marked between-school differences in children's cognitive test performance, which were apparent already at the early age of seven and which were partly explained by compositional effects. As has been highlighted in the review of the literature, there is a wealth of evidence linking markers of childhood cognition to adult life chances such as employment, earnings and social class (e.g. Heckman et al., 2006; Johnson et al., 2010; von Stumm et al., 2010; Cheng and Furnham, 2012). Therefore, early intervention plays a pivotal role in reducing existing inequalities, and schools appear to be an important area for investment. Previous research from the US has shown some impressive results for what can be achieved when schools are targeted and substantial resources are made available (Dobbie and Fryer, 2011). The inequalities between schools require attention and prioritisation within the wider context of education policy – good schools need to be available for all. Schools serving areas where disadvantage is higher and pupils have complex needs will need adequate funding (Lupton, 2004).

Area Based Initiatives can be justified if they are evaluated and based on scientific evidence of "what works". ABI which are rolled out only in the most disadvantaged areas will not reach all families who might need them (Joshi et al., 2000). As has been shown earlier, about 50% of MCS families affected by relative poverty do not live in the most deprived neighbourhoods. Also, there is a danger that programmes designed for areas (or families) who are labelled as "high risk" become associated with stigma and are consequently poorly received.

Acknowledging the shortcomings of only targeting the most disadvantaged, the Marmot Review on Health Inequalities in England suggests what it termed "proportionate universalism", meaning universal measures that are implemented on a scale which is proportionate to the level of disadvantage (Marmot, 2010). Applied to neighbourhoods, this could mean for example, making funds available to local authorities for the provision of subsidised high quality after-school care in local schools, but giving relatively more resources to schools in disadvantaged neighbourhoods and thereby "levelling up" these areas. Such a measure could benefit children by providing stimulating learning and play experiences, while at the same time helping mothers who want to work but find it difficult to afford childcare. When evaluating such measures, the emphasis should be not only on outcomes, but also on the processes involved, such as acceptability and participant's satisfaction (Nutbeam, 1998).

This research has also shown that social processes within the neighbourhood play a role for the well-being of mothers and children. Enhancing residents' sense of cohesion and feelings of safety should be part of neighbourhood initiatives where feasible.

An example of an area-based policy with great potential to positively influence child outcomes as well as fostering a sense of community are England's Sure Start Children's Centres. Sure Start Local Programmes were established in 1998 with the aim to bring integrated services for young children to disadvantaged areas and with a commitment to involve parents and to strengthen communities (Lewis, 2011). The programme underwent several changes and from 2005, the Sure Start Local Programmes were transformed into universally rolled out Sure Start Children's Centres. While early programme evaluation has produced mixed findings, later evaluation studies have been more encouraging (Melhuish et al., 2008a), however assessing the impact of the programme has been complicated by the substantial variation across areas in the way it was implemented, and more detailed and long-term evaluation is still needed.

9.8 Concluding remarks

This research set out with the question of whether it matters where children grow up. The best answer, given the findings from previous studies and from this project, is yes, it does matter. While the present results, like those of most other neighbourhood studies before, highlight the fundamental importance of family socio-economic position and especially maternal education, children's experiences within their neighbourhoods and schools do contribute to their social and cognitive development.

In terms of progressing neighbourhood research on child development, the most salient finding of this research is the importance of including schools as a level of influence when estimating the variability in markers of children's cognitive ability.

From a policy perspective, schools have the potential to alleviate existing inequalities in children's cognitive development and thus to enhance the life chances of children from all backgrounds. Every child has the right of access to good-quality education, which should not be hampered by living in a neighbourhood with the wrong postcode.

Given that families' individual circumstances play such an important role for children's early development, policies directed at neighbourhoods and schools need to be complemented by policies which support families directly.

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Appendices

Appendix I Tables summarising details of individual studies included in the literature review

Table 11-1 Details of studies on neighbourhood effects on children's socio-emotional development

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
1998 Shumow, Vandell & Posner	Cross-sectional/ multiple regression	Parent, teacher and child reports of child misconduct and psychological distress	168 children aged 10-11 from Milwaukee, USA	Census tracts (2,500 - 8,000 persons)	Neighbourhood income, % female headship, median education for adults; neighbourhood risk derived from crime statistics; parent and child perceptions of danger	Higher median income associated with less distress; Perceived danger (parent and child) mediated association between neighbourhood risk and child distress (both parent and child-reported); Perceived danger (parent) mediated association between neighbourhood risk and child misconduct (parent-reported); no association between parent and child perceptions of danger and teacher-reported distress or misconduct
1999 Greenberg et al.	Longitudinal/ multiple regression and path analysis	Child internalising (parent) and externalising behaviour (parent and teacher) social competence (teacher)	337 children followed from last kindergarten year (aged 6) to end of 1st grade, from 4 areas of the USA	Subjective	Neighbourhood risk index (Parent perceived neighbourhood safety, interviewer assessed area safety and noise levels)	Neighbourhood risk associated with more parent-reported externalising behaviour, higher teacher-reported authority acceptance and lower social competence; association between neighbourhood risk and behaviour problems stronger for boys than for girls; Maternal depression on the pathway between perceived neighbourhood risk and parent-reported externalising behaviour

[1] Final results of all listed studies adjusted for varying family level socio-demographic covariates unless otherwise indicated / all ICC's unadjusted unless stated otherwise

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
1999 Stiffman et al.	Cross-sectional/ Structural equation modelling (SEM)	Adolescent mental health	792 adolescents aged 14-18, St. Louis Youth Services Project, USA	Census tracts	Perceived neighbourhood problems e.g. drug dealing, homelessness, shootings; objective environment via police reports of crime rates	Perceived problems associated with worse mental health; Objective environment not significantly associated with adolescent mental health
2000 Gorman-Smith, Tolan and Henry	Longitudinal, cluster analysis, multiple regression	Delinquent involvement	288 “high-risk” boys aged 11-14, Chicago Youth Development Study, USA	Tract clusters (neighbourhood profiles)	Structural risk via concentrated poverty, ethnic heterogeneity, disinvestment and violent crime; neighbourhood social organisation via mother and child report of belonging, support, involvement; fear of crime/disorder	3 neighbourhood clusters derived based on structural risk; Boys in clusters with high structural risk and low social organisation more likely become offenders than those in low structural risk cluster; Interaction: boys from high risk families (low discipline and cohesion) less likely to offend if living in cluster with high structural risk but functioning social organisation
2000 Kowaleski-Jones	Cross-sectional/ multiple regression	Aggressive behaviour	860 adolescents aged 14-18, NLSY study, USA	Zip codes	Neighbourhood residential stability, % female headship, % high-school dropout, % residents twice above poverty line; maternal perceptions of school quality and neighbourhood disorder	All neighbourhood and school measures except proportion of high-school dropouts associated with aggressive behaviour in expected direction, but only if estimated separately; In model with all neighbourhood exposures only residential stability and perceived higher school quality significantly associated with less aggressive behaviour
2001 Kalff et al.	Cross-sectional/ multilevel models	Child problem behaviour (Child Behaviour Checklist)	734 children aged 5-7, from Maastricht, Netherlands	Administrative boundaries	Neighbourhood socio-economic deprivation	Neighbourhood socio-economic deprivation associated with more behaviour problems; ICC not reported

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2001 Katz, Kling & Liebman	Randomised experiment/ multiple regression	Behaviour problems	612 children aged 6-15 from Moving To Opportunity Project, Boston, USA	Census tracts	Neighbourhood poverty rate, eligible families resided in census tracts with poverty rate >40%; experimental group offered to move into area with <10% poverty rate	Take up rate in experimental group= 47%; For both Intention To Treat / Treatment On Treated significantly lower behaviour problems in boys compared to control group
2001 Ludwig, Duncan & Hirschfeld	Randomised experiment/ multiple regression/ Poisson regression	Juvenile delinquency/ arrests	336 children aged 11-16 from Moving To Opportunity Project, Baltimore, USA	Census tracts	Neighbourhood poverty rate, eligible families resided in census tracts with average poverty rate of 67%; experimental group offered to move into area with <10% poverty rate	Take up rate in experimental group= 54%; families with children at higher risk of delinquency more likely to move; Experimental group less likely to be involved in delinquency compared to control group
2002 Boyle & Lipman	Cross-sectional/ multilevel models	Behaviour problems, parent and teacher-assessed	12,592 children aged 4-11 from cycle 1 of the NLSCY study, Canada	Enumeration Areas	Neighbourhood disadvantage; percentage lone parent families	Higher percentage of lone parents predicted more behavioural problems; fewer behavioural problems found in children from well-off families living in disadvantaged neighbourhoods, and more problems found in children from poor families living in advantaged neighbourhoods **ICC parent reported problem behaviour = 7.6%; teacher-reported = 6.6%**
2002 Kohen et al.	Cross-sectional/ multiple regression	Behaviour problems	3,350 children aged 4-5 years from NLSCY study, Canada	Enumeration areas (based on Census data)	Neighbourhood income, family structure and unemployment; physical and social disorder (interviewer observations); cohesion (parent reported)	Neighbourhood affluence associated with fewer behaviour problems; low cohesion associated with more behavioural problems

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2002 Rankin & Quane	Cross-sectional/ multilevel models	Problem behaviour, prosocial competence	636 African-American children aged 11-16 years from Chicago, USA	Census tracts	Neighbourhood concentrated disadvantage, residential stability, collective efficacy	None of the neighbourhood characteristics associated with either outcome **ICC problem behaviour = 4%; prosocial competence = 21%**
2003 Caughy, O'Campo & Muntaner	Cross-sectional/ multiple regression	Behavioural problems (internalising and externalising) via Child Behaviour Checklist	200 African-American children (aged 3 - 4 ½ years) from 39 neighbourhoods in Baltimore, USA	Census block groups	Parental psychological sense of community (sense of membership, emotional connection, degree of mutual influence with the neighbourhood)	Lack of attachment to community associated with more behaviour problems for children living in wealthy communities but with fewer behaviour problems for children living in poor neighbourhoods
2003 Drukker et al.	Cross-sectional/ multilevel models	Children's health-related quality of life including mental health, self-esteem, satisfaction and behaviour scales	563 children aged 10-13 from Maastricht, Netherlands	Administrative boundaries	Neighbourhood socio-economic deprivation and residential instability; social capital (informal social control, social cohesion and trust) via community survey	Neighbourhood socio-economic deprivation not independently associated with child mental health and behaviour; mental health and behaviour were specifically associated with informal social control; no interaction between family-level and neighbourhood deprivation, no direct effect of neighbourhood deprivation ICC not reported
2003 Guerra, Rowell Huesmann & Spindler	Longitudinal/ hierarchical linear growth curve models, SEM	Aggressive behaviour (assessed by teachers and peers) and normative beliefs about aggression	4,458 children (1st to 6th grades) from 21 schools in disadvantaged areas in Chicago, USA	Subjective	Exposure to neighbourhood violence as reported by the child (using a subscale of the stressful events scale by Attar et al.)	Exposure to community violence increased children's subsequent aggressive behaviour and social cognition supporting aggression; effects of violence exposure on aggressive behaviour was in part mediated by normative beliefs; associations not significantly different for boys versus girls

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2003 Schneiders et al.	Longitudinal/ multilevel models	Child behavioural and emotional problems (Child Behaviour Checklist, Youth Self-Report)	2,587 children aged 10-14 years, from 74 neigh-bourhoods in Rotterdam, Netherlands	Administrative boundaries	Neighbourhood socioeconomic disadvantage	Neighbourhood disadvantage was associated with more total, internalising, and externalising problems; and also with change (i.e. increases) in total problems over the 2 year follow up period; **ICC = 1.6%**
2003 López Turley	Cross-sectional/ multiple regression	Positive and negative behaviour (parent report)	3,563 children aged 3-12 from PSID-CDS study, USA	Census tracts	Neighbourhood median income and racial composition	Higher median income associated with better behaviour only in older children (8-12 years)
2003 Van der Linden et al.	Cross sectional case-control/ multilevel models	Children's mental health service use	262 children aged 6-13 (56 cases and 206 controls) from Maastricht, Netherlands	Administrative boundaries	Neighbourhood socioeconomic deprivation; Social capital (social cohesion and trust) via aggregated responses to a community survey	Children living in deprived neighbourhoods were more likely to use mental health care services; the effect of neighbourhood socioeconomic deprivation on mental health service use was stronger in neighbourhoods with lower levels of social cohesion and trust; ICC not reported
2004 Curtis, Dooley & Phipps	Cross-sectional/ multivariate regression	Conduct disorder, hyperactivity, emotional disorder	11,037 children aged 4-11 from the NLSCY study, Canada	Subjective	Respondents' perceptions of neighbourhood safety and cohesiveness; neighbourhood problems such as garbage or drugs reported by both respon-dents and interviewers	Neighbourhood cohesion positively associated with all outcomes; safety associated with conduct and emotional disorder as well as hyper-activity; respondent-reported problems associated with all outcomes; interviewer reported problems with hyperactivity

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2004 Ford, Goodman & Meltzer	Cross-sectional/ multiple regression	Childhood psychiatric disorder (DSM-IV diagnosis with expert input)	6,685 children aged 5-15 from British Child and Adolescent Mental Health Survey 1999, England	Enumeration districts (about 100 households)	Neighbourhood deprivation via Carstair's Index; school disadvantage via index constructed from OFSTED reports	When mutually adjusted for family socio-demographic factors, parental depression, stressful life events, child cognitive ability and child neurodevelopmental disorder, neither neighbourhood deprivation nor school disadvantage independently associated with any psychiatric disorder; Rented housing independently associated with Oppositional Defiant Disorder (OR = 2.0) and conduct disorder (OR = 1.9) compared to home ownership
2004 Simons et al.	Cross-sectional/ multilevel models	Child conduct problems (caretaker reports and child self-reports)	774 African-American children aged 10-12 years, in Iowa and Georgia, USA	Block Group Areas combined into community groups using cluster analyses	Neighbourhood disadvantage derived from Census data; collective socialisation (care-taker-reported, aggregated) and community crime (child-reported, aggregated)	With all 3 measures in the same model, a strong association was found between higher levels of collective socialization and fewer conduct problems; neighbourhood disadvantage and community crime had no significant effect **ICC = 16%**
2005 Kling, Ludwig & Katz	Longitudinal/ Randomised experiment/ weighted multiple regression	Youth crime and delinquency between randomisation and follow up (4-7 years)	6,280 youth aged 15-25 at follow-up (treatment and control) from MTO project, USA	Census tracts	Neighbourhood poverty rate; experimental group offered to move into area with <10% poverty rate	Outcomes differ by gender: offer to move into low poverty neighbourhoods reduced arrests for female youths, while male youth from the experimental groups had a reduction in violent crime accompanied by increases in problem behaviour and property crime compared to control

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2005 Romano et al.	Cross-sectional/ multilevel models	Physical aggression and prosocial behaviour	2,745 children aged 2-11 nested in 1,982 families nested in 96 census tracts from the NLSCY study, Canada	Statistics Canada 1996 census tracts	Percentage of families below poverty level; neighbourhood problems (disorder); collective efficacy	Adjustments include maternal depression, parenting, family dysfunction and social support: *Lower* levels of aggression in neighbourhoods with higher poverty; more neighbourhood problems associated with more aggression; no association with collective efficacy; neighbourhood variables not associated with prosocial behaviour; mediation not tested **ICC (adjusted for child age and sex) physical aggression = 4%; prosocial behaviour = 9%**
2005 Xue et al.	Longitudinal/ multilevel models	Child mental health (internalising behaviour problems via Child Behaviour Checklist)	2,805 children aged 5 to 11 years from 80 neighbourhoods in Chicago, USA	Census tracts	Neighbourhood concentrated disadvantage, immigrant concentration, residential stability; Collective efficacy and organisational participation via community survey	Children living in disadvantaged, poor neighbourhoods had significantly worse mental health, after adjusting for children's mental health 2 years earlier; collective efficacy mediated the effect of concentrated disadvantage **ICC = 11%**
2006 Barnes & Cheng	Cross-sectional/ multiple regression	Behaviour problems	463 children aged 5 and 12 years, from disadvan-taged neighbour-hoods in England	Subjective	Caregiver's perceptions: local networks, neighbourhood attachment, exposure to crime, local parenting behaviour	Higher neighbourhood attachment associated with fewer behaviour problems, exposure to crime predicted more problems but not after parenting behaviour was accounted for; no mediation via maternal depression
2006 McCulloch	Cross-sectional/ multilevel models	Behavioural adjustment	912 children aged 7 and older, from 658 families living in England and Wales from NCDS 1991 sweep	Electoral wards	Ten categories of neigh-bourhoods according to the ONS classification of wards	Substantial variations between neighbourhood types; children in Deprived City Areas had more behaviour problems; limited evidence for mediation via maternal psychological health and home environment ICC not reported

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2007 Fauth, Leventhal & Brooks-Gunn	Longitudinal/ quasi-experimental/ multiple regression	Behaviour problems and delinquency	221 low income, minority children aged 8-18 (128 movers and 93 stayers) followed over 7 years, Yonkers Project, New York, USA	Census tracts	Yonkers Family and Community Project, housing lottery - selected movers were relocated from high-rise public housing into newly built townhouses in middle-class, White areas	Seven years after relocation, movers lived in significantly more advantaged neighbourhoods compared to stayers; Movers exhibited more anxious/depressed problems than stayers, no differences regarding delinquency; Significant interactions by child age at programme entry regarding hyperactivity: among 8-11 year olds, movers had slightly fewer problems but at older ages movers had more problems
2007 Kling, Liebman & Katz	Longitudinal/ Randomised experiment/ weighted multiple regression	Mental health (psychological distress, anxiety, depression) ca. five years after enrolment in Moving To Opportunity Project	1,807 youth aged 15-20 (treatment and control) from MTO project, USA	Census tracts	Neighbourhood poverty rate; experimental group offered to move into area with <10% poverty rate	Significant differences by gender: Female youth outcomes: large benefits in mental health outcomes / less risky behaviour in treatment group compared to control; Male youth outcomes: adverse effects in treatment group versus control - more injuries, more substance abuse, no effect on mental health outcomes
2007 Meltzer et al.	Cross-sectional/ multiple regression	Emotional disorder and conduct disorder, case vignette approach (clinician ratings)	3,340 children aged 11-16 years, in 426 postal sectors in Great Britain	Census Enumeration Districts and subjective	Neighbourhood trustworthiness and safety (child-reported); neighbourhood SES according to ACORN classification	Strong associations between low levels of perceived neighbourhood trust and safety and emotional disorders; low trust also associated with conduct disorder
2007 Oliver et al.	Cross-sectional/ multilevel models	Early Development Instrument (EDI), includes physical health, social development and cognitive abilities	3,736 children aged 5 and 6 years, in Vancouver, Canada	Census tracts	Neighbourhood SES (derived from Census data on median family income, education, unemployment, lone-parent families, residential stability, mother-tongue English)	Neighbourhood SES accounted for up to 15% of the total variance in EDI scores, effects were larger for cognitive than for emotional and behavioural development **ICC emotional health/maturity = 4.9%; social knowledge and competence = 5.6%**

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2008 Kohen et al.	Longitudinal/ SEM	Behaviour problems	3,528 children (outcome measured at ages 4-5 years) from NLSCY study, Canada	Enumeration areas (based on Census data)	Neighbourhood disadvantage (income, education, family structure and unemployment); cohesion (parent reported and aggregated)	No direct effect of neighbourhood SES but indirect effects: for behaviour problems, the path was neighbourhood cohesion → maternal depression → punitive parenting
2009 Carpiano, Lloyd & Hertzman	Cross-sectional/ multilevel models	Early Development Instrument (EDI), includes physical health, social development and cognitive abilities	37,798 children (age 5) from 433 neighbourhoods in British Columbia, Canada	Neighbourhood boundaries deter-mined in coalition with local representatives	Index of Concentration at the Extremes (ICE) measuring concentrations of affluence and disadvantage	EDI scores increased with increasing concentration of affluence; relationship curvilinear for physical and social development scores i.e. higher scores in more heterogeneous neighbourhoods, linear relationship for cognitive scores ICC not reported
2009 Edwards & Bromfield	Cross-sectional/ multilevel models	Conduct problems and prosocial behaviour	4,983 children aged 4-5 from 257 neighbourhoods in Australia	Australian post-codes (between 12,000 and 15,000 residents)	Parental perceptions of neighbourhood facilities, belonging, safety and cleanliness; neighbourhood SES, residential stability and ethnic homogeneity; accessibility/remoteness; interviewer observations of disorder (deteriorated buildings nearby)	Neighbourhood socio-economic disadvantage (but not residential stability, ethnic homogeneity and remoteness) associated with more conduct problems, effect partially mediated by parental perceptions of safety and belonging; cleanliness and belonging associated with more prosocial behaviour; perceptions of facilities and interviewer rated disorder did not contribute additionally **ICC conduct problems = 2%; pro-social behaviour = 0%**
2009 Flouri, Tzavidis & Kallis	Longitudinal/ multilevel models	Emotional and behavioural problems via Strengths and Difficulties Questionnaire	9,630 children aged 2-15 nested in 6052 families nested in 1,681 areas from MCS, UK	Lower-layer Super Output Areas	Index of Multiple Deprivation (IMD)	No association between area deprivation and behavioural problems after controlling for family-level SEP **ICC in three-level model adjusted for age, sex, biological relation between family members and MCS design strata = 2.5%** (MCS design strata contain information on area deprivation/ ethnic composition)

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2009 Odgers et al.	Longitudinal/ Latent growth curve modeling	Antisocial behaviour over time via Achenbach Antisocial Behaviour Scale, mother- and teacher reports	2,232 children aged 5-10 from E-Risk Longitudinal Twin Study, England and Wales	Enumeration districts, subjective	Neighbourhood SES according to ACORN classification via postcode (affluent = ACORN 1-3, deprived = ACORN 4-6); Collective efficacy and neighbourhood problems via community survey	Deprivation associated with more antisocial behaviour and slower decline in antisocial behaviour between ages 5 and 10, adjusted for domestic violence and child maltreatment; Higher collective efficacy associated with lower initial levels of antisocial behaviour in deprived neighbourhoods only, but not with the rate of change over time
2010 Lima et al.	Cross-sectional/ multiple regression	Behaviour problems (Internalising and externalising) via Child Behaviour Checklist	405 children in 1st grade from Baltimore, USA	Census Block Groups	Neighbourhood concentrated disadvantage; Neighbourhood negative social climate; community involvement with children	Neighbourhood negative social climate moderated the association between family risk (including maternal depression) and child externalising behaviour: in neighbourhoods with better social climate the number of family risks was less strongly associated with behaviour problems than in neighbourhoods with more negative social climate; associations did not differ by gender
2010 Renzaho & Karantzas	Cross-sectional/ SEM	Child prosocial behaviour and difficult behaviour via Strengths and Difficulties Questionnaire	2,886 children aged 4-12, from Victorian Child Health and Wellbeing Survey, Australia	Subjective	Perceived neighbourhood environment (8 items), factor analysis identified 3 constructs: safety and cleanliness, infrastructure and accessibility, neighbourhood services	None of the neighbourhood variables associated with prosocial behaviour; Worse infrastructure associated with more behavioural difficulties; renting associated with more behavioural difficulties compared to house-owners; parental psychological distress associated with housing tenure and neighbourhood infrastructure/accessibility but mediation not explicitly tested

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2010 Vaden-Kiernan	Cross-sectional/ longitudinal/ multilevel models	Child behaviour problems (parent and teacher-report) via Achenbach Child Behaviour Checklist	4,222 children aged 3 and 4 from 1,720 Head Start areas, Family and Child Experiences Survey, USA	Census Tracts	Five neighbourhood factors derived from 40 census variables: Low SES; "English as a second language" (ESL); High SES; "Mobile, Young and Diverse" (MYD); Family Density	Low SES, ESL and High SES associated with fewer behavioural problems (parent report); ESL associated with fewer behaviour problems (teacher report) compared to average neighbourhood; no mediation effects for family factors **ICC Total Behaviour Problems (parent) = 11%; ICC (teacher) = 12%**
2011 Leventhal & Brooks-Gunn	Longitudinal/ multilevel models	Problem behaviour (internalising, child self reported violence, property offences)	3,324 children and youths (age 10-15) followed over 6 years, PHDCN study, Chicago, USA	Neighbourhood cluster (2-3 census tracts)	Changes in neighbourhood poverty levels between 1990 and 2000, measured via census data; separate analyses for high/moderate/ low initial poverty	High poverty neighbourhoods: compared to stable, *decreasing* poverty associated with more internalising and more violent behaviour, association much stronger for boys than for girls; moderate poverty neighbourhoods: *increasing* poverty associated with more internalising problems, association large for boys and small for girls; decreasing poverty not associated with any outcome; low poverty neighbourhoods: increasing poverty associated with faster increase in violent behaviour in boys but not in girls **Unconditional ICC internalising problems = 6% (parent report) and 5% (self report)**
2011 Sanson, Smart & Misson	Longitudinal/ multiple regression	Socio-emotional adjustment via Strengths and Difficulties Questionnaire (parent-reported)	Up to 2,411 children followed from age 4-5 to age 8-9, Australia	Australian postcodes / subjective	Neighbourhood socio-economic advantage / disadvantage; neighbourhood belonging (parent-reported)	Neighbourhood advantage at age 3-4 but not age 6-7 weakly associated with better adjustment at age 8-9; Neighbourhood belonging at ages 3-4 and 5-6 associated with better adjustment at age 8-9, association reduced after adjustment for maternal distress and parenting factors

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2012 Eriksson et al.	Cross-sectional/ multiple regression	Child subjective health complaints (e.g. headache, irritability, nervousness) and life satisfaction)	3,926 children aged 9-11 from Swedish Health Behaviour in School Aged Children Survey	Subjective	Child reported neighbourhood social capital and school social capital	Neighbourhood and school social capital both independently associated with fewer subjective health complaints and higher well-being
2012 Flouri, Mavroveli & Tzavidis	Cross-sectional/ multilevel models	Emotional and behavioural problems via Strengths and Difficulties Questionnaire	9,736 children aged 3 from MCS, UK	Lower-layer Super Output Areas	Index of Multiple Deprivation (IMD)	Neighbourhood deprivation associated with peer problems after adjusting for parental mental health; effect of neighbourhood deprivation on internalising problems mediated by maternal mental health; no association with externalising problems after controlling for family SES; association between deprivation and internalising problems less strong in children with higher cognitive ability **ICC total difficulties (adjusted for MCS design strata) = 3.3%**
2012 Odgers et al.	Longitudinal/ Latent growth curve modelling; SEM	Antisocial behaviour over time via Achenbach Antisocial Behaviour Scale, mother- and teacher reports combined	2,232 children aged 5-10 from E-Risk Longitudinal Twin Study, England and Wales	Enumeration districts	Neighbourhood SES according to ACORN classification	Neighbourhood SES associated with antisocial behaviour; gap between deprived versus affluent neighbourhoods widened over time; boys in deprived neighbourhoods did not experience expected improvements in antisocial behaviour over time; maternal warmth and parental monitoring mediated association between neighbourhood deprivation and aggressive behaviour

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2012 Singh & Ghandour	Cross-sectional/ multiple regression	Serious behavioural problems via Behavioural Problems Index	62,804 children aged 6-17 from 2007 National Survey of Children's Health, USA	Subjective	Perceived neighbourhood disorder (safety, litter, dilapidated buildings, vandalism, graffiti)	Children in neighbourhoods with least favourable conditions had higher odds of serious behavioural problems (OR = 1.9; CI 1.26,2.74) than children in most favourable areas net of family SES; association reduced after controlling for potential mediators including social participation, sleep pattern and physical activity

Table 11-2 Summary of studies: neighbourhood effects on children's cognitive development

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
1998 Klebanov et al.	Longitudinal/ multiple regression	Cognitive functioning (Bayley Scale of Mental Development and Stanford-Binet Intelligence Scale)	347 low-birth-weight children (aged 1-3 years) from IHDP study, USA	Census tracts, Enumeration Districts and Minor Civil Divisions	Neighbourhood income	Neighbourhood affluence associated with higher IQ scores only at age three, association became nonsignificant after adjusting for the home environment
1999 Greenberg et al.	Longitudinal/ multiple regression and path analysis	Cognitive test scores at the end of 1^{st} grade	337 children followed from last kindergarten year (aged 6) to end of 1^{st} grade, USA	Subjective	Neighbourhood risk index (Parent perceived neighbourhood safety, interviewer assessed area safety and noise levels)	No association between neighbourhood risk and cognitive test scores after adjustment for family socio-demographic factors
2001 McCulloch & Joshi	Cross-sectional/ multiple regression	Cognitive test scores (Peabody Picture Vocabulary Test)	2,290 children (4-18 years old) from 1532 families from NCDS 1991 sweep, UK	Electoral wards	Townsend indicator of deprivation	Higher levels of neighbourhood deprivation were associated with poorer cognitive outcomes for children between the ages of 4 and 5 years only, effect sizes were small; no evidence of mediation via home environment
2002 Ainsworth	Cross-sectional/ multiple regression	Educational achievement (maths/reading test scores)	13,196 youths (10^{th} grade) who were residentially stable for at least 4 years, National Education Longitudinal Study, USA	Zip codes	Neighbourhood context (high-status residents, residential stability, economic deprivation, ethnic heterogeneity); School characteristics	Only proportion of high status residents associated with better test scores (size of effect comparable to that of attending private school), but not deprivation (adjusted for family SES); association partly mediated by educational expectations and time spent on homework; low teacher quality associated with lower scores; better school atmosphere with higher scores

[1] Final results of all listed studies adjusted for varying family level socio-demographic covariates unless otherwise indicated / all ICC's unadjusted unless stated otherwise

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2002 Kohen et al.	Cross-sectional/ multiple regression	Verbal ability	3,350 children (aged 4-5 years) from NLSCY study, Canada	Enumeration areas (based on Census data)	Neighbourhood income, family structure and unemployment; Physical and social disorder (interviewer observations); Cohesion (parent reported)	Neighbourhood affluence associated with better verbal ability; neighbourhood disorder and low cohesion negatively associated with verbal ability
2003 Rauh et al.	Longitudinal/ multilevel models	Reading scores at grade 3	3,693 African American and Hispanic Head Start children born and attending school up to 3rd grade in NYC, USA	NYC Health Areas, containing 4-6 census tracts	Neighbourhood concentrated poverty and percentage of immigrants	Concentrated community poverty was associated with lower reading scores, while high percentage of immigrants in the community predicted higher scores ICC not reported
2003 Turley	Cross-sectional/ multiple regression	Composite test score (verbal ability and maths, Woodcock-Johnson)	3,563 children aged 3-12 from PSID-CDS study, USA	Census tracts	Neighbourhood median income and racial composition	Median income associated with test scores for White children, no evidence for curvilinear relationship; for Black children association only present in predominantly Black neighbourhoods; effect only significant for children who had lived in neighbourhood >3 years
2006 McCulloch	Cross-sectional/ multilevel models (children nested in families)	Cognitive ability	912 children aged 7 or older from 658 families living in England and Wales from NCDS 1991 sweep	Electoral wards	Ten categories of neighbourhoods according to the ONS classification of wards	Substantial variations between neighbourhood types; children in Deprived City Areas and Middling Britain had lower cognitive test scores; higher scores in Prosperous Areas; no evidence of mediation via maternal psychological health or home environment

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2006 Caughy & O'Campo	Cross-sectional/ multilevel models	Cognitive competence (Kaufman Assessment Battery for Children)	200 African-American children (aged 3 - 4 ½ years) from 39 neighbourhoods in Baltimore, USA	Census block groups	Economic impoverishment and population instability; Neighbourhood social capital and neighbourhood negative social climate	Neighbourhood poverty associated with poorer problem-solving skills; higher social capital levels associated with better cognitive skills; neither social capital nor parenting activities mediated relationship between neighbourhood poverty and cognitive competence ICC not reported
2006 Sanbonmatsu et al.	Longitudinal/ Randomised experiment/ weighted multiple regression	Cognitive ability via reading and math tests (Woodcock-Johnson) 4-7 years after enrolment in MTO Project	Up to 5,248 children aged 6-20 at follow-up (treatment and control) from MTO project, USA	Census tracts	Neighbourhood poverty rate / other census derived characteristics; experimental group offered to move into area with <10% poverty rate; School type, school SES, child reported school climate	Take up rate in experimental group= 47%; Experiment group children moved to substantially less poor neighbourhoods (subsequent moves tended to be into poorer areas) but attended schools that were only slightly more advantaged compared to control; No evidence for improvements in reading or math scores in experimental compared to control group at any age
2007 Fauth, Leventhal & Brooks-Gunn	Longitudinal/ quasi-experimental/ multiple regression	Maths and reading test scores (Woodcock-Johnson)	221 low income, minority children aged 8-18 (128 movers and 93 stayers) followed over 7 years, Yonkers Project, New York, USA	Census tracts	Yonkers Family and Community Project, housing lottery: movers were relocated from high-rise public housing into newly built townhouses in middle-class, White areas	Seven years after relocation, movers lived in significantly more advantaged neighbourhoods compared to stayers; no difference between movers and stayers regarding cognitive test scores; No significant interactions by child age

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2007 Oliver et al.	Cross-sectional/ multilevel models	Early Development Instrument (EDI), includes physical health, social development and cognitive abilities	3,736 children aged 5 and 6 years, in Vancouver, Canada	Census tracts	Neighbourhood SES (derived from Census data on median family income, education, unemployment, lone-parent families, residential stability, mother-tongue English)	Neighbourhood factors accounted for up to 15% of the total variance in EDI scores, with family income and English as a second language most strongly associated with children's readiness to learn; effects were larger for cognitive than for emotional and behavioural development **ICC language/cognitive development = 8.6%**
2008 Kohen et al.	Longitudinal/ SEM	Verbal ability	3,528 children (outcome measured at ages 4-5 years) from NLSCY study, Canada	Enumeration areas (based on Census data)	Neighbourhood structural disadvantage (income, education, family structure and unemployment); sense of cohesion (parent reported/aggregated)	No direct effect of neighbourhood SES but indirect effects: for verbal ability, the path was via neighbourhood cohesion → family functioning → consistent parenting
2008 Sampson, Sharkey & Raudenbush	Longitudinal/ multilevel cross-classified models /causal effects models via Inverse Probability of Treatment Weighting	Verbal ability	2,226 children aged 6-12 at baseline, followed for 7 years, from PHDCN study, Chicago, USA (causal effects models for 772 African-American children)	Census tracts	Cumulative neighbourhood concentrated disadvantage (bottom quartile of a scale created via principal component analysis from census indicators), modelling within-individual changes / moves	No White children in the most disadvantaged quartile, therefore causal effects analysis concentrated on African-American children; In a balanced sample (constructed using IPTW weighting), concentrated disadvantage experienced at wave 1 reduced later (wave 2) verbal ability by > 25% SD; time lag about 2.5 years; no association between concurrent disadvantage and verbal ability scores ICC not reported

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2009 Carpiano, Lloyd & Hertzman	Cross-sectional/ multilevel models	Early Development Instrument (EDI)	37,798 children (age 5) from 433 neighbourhoods in British Columbia, Canada	Neighbourhood boundaries deter-mined in coalition with local representatives	Index of Concentration at the Extremes (ICE) measuring concentrations of affluence and disadvantage	EDI scores increased with increasing con-centration of affluence; relationship curvilinear for physical and social develop-ment scores i.e. higher scores in more heterogeneous neighbourhoods, linear relationship for cognitive scores ICC not reported
2009 Leckie	Longitudinal/ multilevel cross-classified multiple membership models	Educational achievement (GCSE scores) at the end of secondary schooling	42,681 children (National Pupil Database), followed from primary (age 11) to secondary (age 16) school, South West England	Lower Layer Super Output Areas (LSOAs)	Index of Multiple Deprivation (IMD); Rural/urban indicator Secondary school (cohort) level: average intake achievement, proportion of pupils on free school meals	Aim was to estimate variability in GCSE scores between pupils, neighbourhoods, primary and secondary schools taking multiple memberships into account **Of the overall variance, 4% attributed to neighbourhoods; 23% to secondary schools, 3% to primary schools (before adjustments)**
2010 Dupere et al.	Longitudinal/ hierarchical linear growth curve models	Vocabulary, reading and math achievement	1,364 children (aged 54 months to 15 years) from NICHD study, USA	Census block groups	Neighbourhood socio-economic advantage (presence of high-income, educated, professional/ managerial workers); School environment	Positive but curvilinear relationship between neighbourhood advantage and reading / vocabulary scores (association levelled off); home and child care environments were mediators for vocabulary; asso-ciation with reading scores mainly mediated by school environment; no mediation via maternal depression
2010 Lloyd & Hertzman	Longitudinal/ multilevel models	Language and cognitive outcomes	5,022 residentially stable children (followed from ages 4/5 to 9/10) in British Columbia, Canada	Neighbourhood boundaries deter-mined in coalition with local representatives	Index of Concentration at the Extremes (ICE); concentrated immigration; residential instability; proportion of children aged 0–4 years; % Aboriginal	Neighbourhood affluence associated with better Grade 4 outcomes in urban neighbourhoods; concentrated immigration with better outcomes throughout; residential instability with worsening of scores over time ICC not reported

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2010 Lloyd, Li & Hertzman	Longitudinal/ cross-classified multilevel models	Language and cognitive outcomes	2,648 urban children (followed from ages 4/5 to 12/13) in British Columbia, Canada	Neighbourhood boundaries determined in coalition with local representatives	Neighbourhood concentrated disadvantage derived from Census data	Neighbourhood concentrated disadvantage experienced during Kindergarten negatively affected reading comprehension outcomes in Grade 7 **ICC kindergarten neighbourhood/reading = 3.8%; ICC kindergarten neighbourhood/numeracy = 0.7%; ICC grade-7 neighbourhood/reading = 6%; ICC grade-7 neighbourhood/numeracy = 10%**
2010 Rasbash, Leckie & Pillinger	Longitudinal/ cross-classified multilevel models	Educational achievement (GCSE scores) at the end of secondary schooling	551,220 children including 10,232 twins (National Pupil Database), followed from primary (age 11) to secondary (age 16) school, England	Lower Layer Super Output Areas (LSOAs)	Income Deprivation Affecting Children Index (IDACI), no school level variables	Aim was to estimate variability in GCSE scores between pupils, families, neighbourhoods, Local Education Authority (LEA) and schools; **Of the overall variance, 37.8% attributed to pupils; 40.4 to families; 10.3% to secondary schools, 8.5% to primary schools; 1.8% to LSOAs and 1.3% to LEAs** (after adjustments for child age, gender, ethnicity, eligibility for free school meals and statement of special educational needs; IDACI)
2010 Sastry & Pebley	Cross-sectional/ multilevel models	Cognitive skills (reading and maths)	2,350 children aged 3-17 from Los Angeles Family and Neighbourhood Survey, USA	Census tracts	Median family income; racial/ethnic diversity; residential stability; immigrant concentration	Median income had a strong positive effect on both reading and maths skills, particularly at ages 8–17; ethnic diversity and immigrant concentration unrelated to the outcomes; residential stability negatively associated with maths scores ICC not reported

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2010 Vaden-Kiernan	Cross-sectional/ multilevel models	Vocabulary, early writing, letter identification, early math	4,222 children aged 3 and 4 from 1,720 Head Start areas, Family and Child Experiences Survey, USA	Census Tracts	Five neighbourhood factors derived via factor analysis from 40 census variables: Low SES; "English as a second language" (ESL); High SES; "Mobile, Young and Diverse" (MYD); Family Density	Children in Low SES neighbourhoods had lower scores on vocabulary and early math, children in High SES had higher letter identification scores, children in Family Density had lower scores in vocabulary and math compared to average; no mediation effects for any family or social factors **ICC cognitive outcomes: 34% (vocabulary); 6% (writing); 11% letter identification; 13% math**
2011 Burchinal et al.	Longitudinal/ hierarchical linear growth curve models	Academic achievement (Woodcock-Johnson Battery) at ages 4.5, 1st grade and 5th grade; cognitive competence at 36 months	314 Black and White children from lower income families followed from age 4.5 to 5th grade, Study of Early Child Care and Youth Development, USA	Census blocks	Neighbourhood socio-economic disadvantage using census data; Childcare type, quality and child-adult ratio; School demographic risk, observed quality of classroom environment (Classroom Observation System), child-teacher ratio	Black-White achievement gap in reading and maths due mainly to family SES, parenting and school factors; school environments accounted for up to one third of the gap; poor quality schools attended by Black children also contributed to a widening of the gap over time; correlations between maternal depressive symptoms and outcomes weak; not significant in fully adjusted models; in the fully adjusted model, neighbourhood disadvantage associated with better math achievement (wrong direction)
2011 Dobbie & Fryer	Longitudinal/ multiple regression / instrumental variable analysis	Academic achievement via math and English Language Arts (ELA) tests through elementary / middle school	429 elementary and 612 middle school children who were lottery winners/losers to attend a Promise Academy school in Harlem, New York, USA	Harlem's Children's Zone (HCZ)	HCZ was developed in 1997 to tackle the disadvantages of poor children, it included the high quality Promise Academy schools and over 20 community programs to help children and families	Large treatment effects observed: compared to lottery losers (control), middle school children who won the lottery (treatment) had strong gains in math but little gains in ELA; elementary school lottery winners had strong gains in both math and ELA; no differences by gender or free lunch eligibility; effect almost entirely due to the school: no differences in gains between lottery winners who lived inside/outside HCZ while siblings of winners who were themselves not eligible for the school showed little to no effect on achievement

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood/school aspects measured	Key findings[1]
2011 Greenman, Bodovski & Reed	Longitudinal/ multilevel models	Math achievement at grade 5 (mean age 11) (test score)	10,049 children in 5th grade, from Early Childhood Longitudinal Study, USA	Census tracts	Neighbourhood disadvantage via census derived scale of 8 items including % living in poverty, median income, % single parents, % unemployed, % highly educated	Models adjust for grade 1 test scores to minimise selection bias; neighbourhood disadvantage associated with lower maths achievement in grade 5; neighbourhood effect not mediated via parental educational practices but significant interaction: association between parenting practices and math achievement stronger in highly disadvantaged neighbourhoods ICC not reported
2011 Sanson, Smart & Misson	Longitudinal/ multiple regression	Learning competencies (vocabulary and matrix reasoning tests; teacher rated literacy and maths) at age 8-9	Up to 2,411 children followed from age 4-5 to age 8-9, Longitudinal Study of Australian Children, Australia	Australian postcodes / subjective	Neighbourhood socio-economic advantage / disadvantage; Neighbourhood belonging (parent-reported)	Neighbourhood advantage at ages 4-5 independently associated with higher learning competencies at age 8-9; no suggestion of mediation via maternal distress or parenting Association with neighbourhood belonging at age 4-5 weak and no longer significant after family SES adjusted for
2011 Sharkey & Elwert	Longitudinal/ multi-generational, marginal structural models	Child cognitive ability (Broad Reading Scores and Applied Problem Scores) via Woodcock-Johnson Battery	1,556 parent-child pairs (child age 5-18) who were both members of Panel Study of Income Dynamics, USA	Census tracts	Neighbourhood poverty rate >20%	Study aim was to test for the presence of multi-generational neighbourhood effects: Child cognitive ability was reduced on average by more than half of a standard deviation if a family had lived in a high poverty neighbourhood over two consecutive generations - parent's childhood neighbourhood associated with children's cognitive test scores

Table 11-3 Summary of studies: neighbourhood effects on maternal mental health and parenting

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood aspects measured	Key findings[1]
1994 Klebanov, Brooks-Gunn & Duncan	Longitudinal/ multiple regression	Maternal depression, social support and coping; home learning environment	895 mothers of 3-year-old children from IHDP study (low birth weight children), USA	Census tracts	Neighbourhood income (Census data)	Neighbourhood poverty was not associated with maternal depression but with a more negative physical home environment and less maternal warmth
2000 Cutrona et al.	Cross-sectional/ multilevel analysis	Psychological distress (Mini-Mood and Anxiety Symptom Questionnaire)	709 African American women, who were primary caregivers for a 10- to 12-year-old child from the FACHS study, USA	Clusters of Block Group Areas (BGA), BGA = cluster of blocks within a census tract	Community economic disadvantage (aggregated score for each cluster); Perceived community cohesion and community disorder (aggregated over BGA clusters)	Neighborhood economic disadvantage unrelated to distress; community social disorder was associated with depression; community cohesion intensified the benefits of a positive life outlook; community disorder intensified the detrimental effects of personal risk factors ICC not reported
2001 Pinderhughes et al.	Cross-sectional/ multiple regression	Parenting (parental warmth, appropriate and consistent discipline, harsh interactions)	368 mothers from high-risk communities from the control group of Fast Track study, USA	Census tract / subjective	Neighbourhood poverty, residential stability (census data); dissatisfaction with public services, social networks, perceived danger (parent report)	Neighbourhood poverty and perceived danger associated with less parental warmth in European American families; perceived danger associated with less consistent discipline; dissatisfaction with public services but not perceived danger associated with more harsh interactions

[1] Final results of all listed studies adjusted for varying family level socio-demographic covariates unless otherwise indicated / all ICC's unadjusted unless otherwise stated

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood aspects measured	Key findings[1]
2002 Ceballo & McLoyd	Cross-sectional/ multiple regression	Parenting (maternal nurturance, maternal punishment)	262 low-income, single African-American mothers 12-17 year old children, USA	Census tract / subjective	Neighbourhood poverty (census); crime rates (police reports); maternal perception of neighbourhood quality	Neighbourhood quality moderated association between social support and parenting: social support associated with more nurturance and less punitive parenting in neighbourhoods with better quality, but association weak in low quality neighbourhoods; no direct association between neighbourhood quality and punitive parenting
2002 Hill & Herman-Stahl	Cross-sectional/ multiple regression	Maternal depressive symptoms on the CES-D scale; parenting practices	Mothers of 103 kindergarten children from a semi urban city, USA	Subjective	Neighbourhood safety (interviewer ratings and mothers' perceptions) and mothers' social involvement in the neighbourhood	Neighbourhood safety but not mothers' social involvement was negatively related to maternal depression; mothers' perceptions of safety were negatively related to inconsistent disciplinary strategies and withdrawal of relations; interviewer reported safety was negatively related to hostile control strategies; maternal depression mediated the association between perceived neighbourhood safety and inconsistent disciplinary strategies
2003 Christie-Mizell, Steelman & Stewart	Longitudinal/ multiple regression	Maternal psychological distress (CES- D scale)	2,204 mothers from NLSY study (two waves), USA	Subjective (immediate community)	Perceived neighbourhood disorder (physical and social); Inner-city, urban or rural location	Perceived neighbourhood disorder was associated with maternal psychological distress after controlling for baseline levels of distress
2005 Jones et al.	Longitudinal/ multiple regression	Mother-reported monitoring (Monitoring and Control Questionnaire)	248 African American single mothers of 7-15 year old children, USA	Subjective	Maternal perception of neighbourhood violence (gangs, fights, shootings/knifings, drug use, homicides)	Higher levels of perceived violence associated with higher levels of parental monitoring (parent's knowledge about the child's behaviour and whereabouts)

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood aspects measured	Key findings[1]
2005 Kotchick, Dorsey & Heller	Longitudinal/ SEM	Parenting practices and maternal psychological functioning	123 low-income, African American single mothers of 7-15 year olds, New Orleans, USA	Subjective	Perceived neighbourhood stress (including gangs, drug use, fights, homicides, substandard housing, noise, overcrowding)	Study tested the family stress model extended to neighbourhood stressors; exposure to perceived neighbourhood stress predicted higher psychological distress for mothers, which in turn were related to less positive parenting practices 15 months later (poorer mother-child relationship, less monitoring, less consistent parenting); no direct effect of neighbourhood stress on parenting
2005 Mulvaney & Kendrick	Cross-sectional/ multilevel models	Depressive symptoms on the CES-D scale	846 mothers of young children living in deprived areas in Nottingham, UK	Enumeration districts and subjective	Neighbourhood socio-economic disadvantage (Townsend score); perceived neighbourhood social capital	High area deprivation and low area social capital increased the risk of depressive symptoms; after adjusting for self-reported stress the association with low social capital became non-significant ICC not reported
2010 Barnes et al.	Cross-sectional/ multilevel models	Maternal mental health (Malaise Inventory)	14,700 mothers with 9-month-old infants living in 195 deprived neighbourhoods in England	Sure Start Local Programme (SSLP) areas, locally defined	Neighbourhood prosperity (census data); systematic neighbourhood observations; maternal and interviewer ratings of the area	Lower (interviewer-rated) neighbourhood quality and lower neighbourhood prosperity predicted more mental-health problems after adjusting for family-level factors; systematic observations did not contribute additionally ICC not reported
2011 Frech & Kimbro	Longitudinal/ Poisson regression	Mother-reported time investment in their children at age 5 (outings, reading, playing indoors)	3,572 mothers and children aged 1-5 from Fragile Families and Child Wellbeing Survey, USA	Census tracts / subjective	Neighbourhood socioeconomic characteristics (census data); Mother-reported collective efficacy and neighbourhood fear	Maternal depression associated with less time investment and with lower perceived collective efficacy after adjusting for family SEP; low neighbourhood collective efficacy but not neighbourhood socioeconomic characteristics associated with less time investment; however no suggestion of mediation by maternal depression

Year / author	Study design / analysis technique	Outcomes	Study population	Neighbourhood definition	Neighbourhood aspects measured	Key findings[1]
2011 Greenman, Bodovski & Reed	Longitudinal/ multilevel models	Education-related parenting practices (single scale derived from several items on activities, involvement with school and number of children's books)	10,049 parents of children from Early Childhood Longitudinal Study, USA	Census tracts	Neighbourhood disadvantage via census derived scale of 8 items including % living in poverty, median income, % single parents, % unemployed, % highly educated	High neighbourhood disadvantage associated with fewer education-related parenting practices; no evidence of mediation via maternal depression ICC not reported
2011 Spijkers, Jansen & Reijneveld	Cross-sectional/ multilevel models	Parenting Stress Index	9,453 parents of children aged 9-11 from 3 provinces in the Netherlands	"Neighbourhoods" not further defined	Area deprivation score (tertiles), urbanisation	Parenting stress more prevalent in the most deprived areas, but no association after adjustment for family and child background characteristics (included child behavioural difficulties but mediation not explicitly tested) **ICC = 0.9%**

Appendix II Patterns of missing data (item non-response) at sweeps two and four

Table 11-4 Missing data sweep two (item non-response), N = 15,077

	Missing (n)	Missing (%)
Outcome variables sweep two/age 3		
Maternal Kessler-6 score	1,663	11.03
Daily reading	78	0.52
Regular bedtime	78	0.52
Daily shouting	1,915	12.70
Smacking	1,852	12.28
Neighbourhood variables		
Neighbourhood identifier	1	0.01
IMD	1	0.01
Maternal neighbourhood perceptions (score)	116	0.77
Maternal neighbourhood perceptions aggregated score	27	0.18
Interviewer observations (score)	464	3.08
Covariates		
Child gender	0	0.00
Child age	20	0.13
Family income	2,390	15.85
NS-SEC both parents combined	0	0.00
Housing tenure	69	0.46
Maternal NVQ level	25	0.17
Maternal age	61	0.41
Maternal ethnicity	36	0.24
Family structure	68	0.45
Number of children in household	68	0.45

Table 11-5 Missing data sweep four (item non-response), N = 13,222

	Missing (n)	Missing (%)
Outcome variables sweep four/age 7		
Maternal Kessler-6 score	930	4.76
Child SDQ (mother-reported)	456	3.45
Child SDQ (teacher-reported)	4,840	36.6
Reading test score	422	3.19
Maths test score	265	2.00
Pattern construction test score	317	2.40
Neighbourhood / school variables		
Neighbourhood identifier	1	0.01
School identifier	34	0.26
IMD education domain	1	0.01
Neighbourhood median household income	1	0.01
Percentage in LSOA living in social housing	1	0.01
Urban / rural indicator	1	0.01
School fees applicable	86	0.65
Neither friends nor family in the area	85	0.64
No parks/ playgrounds available in the area	89	0.67
Parenting behaviours		
Reading	71	0.54
Bedtime	72	0.55
Smacking	599	4.53
Covariates		
Child sex	0	0.00
Child age	0	0.00
Special Educational Needs (SEN status)	94	0.71
Family income	179	1.35
NS-SEC both parents combined	0	0.00
Housing tenure	130	0.98
Maternal NVQ level	3	0.02
Maternal age	0	0.00
Child ethnicity	58	0.44
Number of children in household	0	0.00
Family structure	0	0.00
Other languages spoken at home	0	0.00
School year	0	0.00
Moved before sweep three	0	0.00

Appendix III Parenting practices, by neighbourhood IMD and maternal neighbourhood satisfaction

Table 11-6 Parenting practices, by IMD decile (sweep two, max. N = 14,998)

	Most deprived	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	Least deprived	Test for trend
Daily reading	43.4	46.8	53.1	56.4	57.7	64.4	69.3	69.5	73.3	75.5	p<0.001
Regular bedtime	66.9	70.5	76.2	77.1	81.2	81.4	85.5	85.5	87.4	91.0	p<0.001
Use of smacking	65.4	67.3	68.7	67.8	69.7	68.4	67.6	65.7	64.7	63.1	p=0.386
Shouting daily	24.7	21.9	20.6	19.0	17.8	15.5	15.5	14.7	13.2	13.3	p<0.001

Table 11-7 Parenting practices, by maternal neighbourhood satisfaction quintiles (sweep two, max. N = 14,951)

	Least satisfied	Second	Third	Fourth	Most satisfied	Test for trend
Daily reading	51.0	58.3	59.3	65.5	71.2	p<0.001
Regular bedtime	73.5	79.6	79.0	83.6	85.9	p<0.001
Use of smacking	67.3	68.7	69.8	66.5	62.3	p=0.001
Shouting daily	22.6	17.5	17.3	15.4	14.8	p<0.001

Appendix IV Cross-sectional analysis of maternal psychological distress, comparison of different neighbourhood exposures – full table

Table 11-8 Results of multilevel models predicting maternal psychological distress (Kessler-6 score) at sweep two, cross-sectional analysis (N=7,766)

	Estimate (Standard Error)		
	Model D	**Model E**	**Model F**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	-0.19 (0.14)	-0.14 (0.14)	-0.07 (0.14)
England – ethnic	-0.39 (0.23)	-0.20 (0.22)	-0.19 (0.22)
Wales – advantaged	-0.03 (0.19)	-0.09 (0.19)	-0.12 (0.19)
Wales – disadvantaged	-0.15 (0.16)	-0.16 (0.16)	-0.16 (0.16)
Scotland – advantaged	-0.27 (0.17)	-0.29 (0.17)	-0.32 (0.17)
Scotland – disadvantaged	-0.05 (0.19)	-0.02 (0.19)	0.04 (0.19)
NI – advantaged	-0.41 (0.21)	-0.43 (0.21)*	-0.46 (0.21)*
NI – disadvantaged	0.22 (0.21)	0.18 (0.21)	0.12 (0.21)
Individual level covariates			
Maternal age (years)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Maternal ethnicity (ref = White)			
Mixed	0.11 (0.49)	0.07 (0.50)	0.08 (0.50)
Indian	1.24 (0.34)***	1.30 (0.34)***	1.23 (0.34)***
Pakistani	2.38 (0.29)***	2.29 (0.29)***	2.21 (0.29)***
Bangladeshi	0.54 (0.58)	0.47 (0.59)	0.40 (0.59)
Black Caribbean	-0.04 (0.38)	-0.11 (0.38)	-0.13 (0.38)
Black African	-0.21 (0.40)	-0.45 (0.40)	-0.42 (0.40)
Other (incl. Chinese)	0.55 (0.23)*	0.51 (0.23)*	0.51 (0.23)*
Family structure (ref = both natural parents			
Natural mother / other partner	0.60 (0.32)	0.61 (0.32)	0.58 (0.32)
Single mother	0.40 (0.14)**	0.39 (0.14)**	0.40 (0.14)**
Maternal NVQ (ref = level 4/5)			
Level 3	-0.02 (0.12)	-0.02 (0.13)	-0.02 (0.13)
Level 2	-0.10 (0.11)	-0.10 (0.11)	-0.09 (0.11)
Level 1	-0.06 (0.17)	-0.07 (0.17)	-0.09 (0.17)
Overseas	0.66 (0.31)*	0.64 (0.31)*	0.65 (0.31)*
None	0.54 (0.16)**	0.52 (0.16)**	0.50 (0.16)**
Weekly family income, per £100	-0.07 (0.02)***	-0.08 (0.02)***	-0.07 (0.02)***

Table 11-8 (continued)

	Estimate (Standard Error)		
	Model D	**Model E**	**Model F**
NS-SEC (ref= manag. / prof.)			
Intermediate	0.08 (0.14)	0.06 (0.14)	0.06 (0.14)
Small empl. / self empl.	-0.33 (0.17)*	-0.34 (0.17)*	-0.37 (0.17)*
Lower supervisory / tech.	0.24 (0.16)	0.23 (0.16)	0.21 (0.16)
Semi routine / routine	-0.07 (0.14)	-0.10 (0.14)	-0.12 (0.14)
No partner in work	0.46 (0.15)**	0.44 (0.15)**	0.43 (0.15)**
Housing tenure (ref= owner)			
Rented privately	0.85 (0.20)***	0.87 (0.20)***	0.80 (0.20)***
Social housing	0.67 (0.13)***	0.80 (0.13)***	0.79 (0.13)***
Other	-0.20 (0.23)	-0.18 (0.23)	-0.21 (0.23)
Neighbourhood exposures			
IMD decile (ref = most deprived)	-0.02 (0.02)	-0.02 (0.02)	-0.04 (0.02)
Maternal neighbourhood satisfaction (ref = most satisfied)			
Second quintile	0.43 (0.13)**		
Third quintile	0.45 (0.13)**		
Fourth quintile	0.80 (0.13)***		
Least satisfied	1.40 (0.14)***		
Aggregated neighbourhood satisfaction (ref = most satisfied)			
Second quintile		0.30 (0.14)*	
Third quintile		0.41 (0.15)**	
Fourth quintile		0.48 (0.18)**	
Least satisfied		0.85 (0.20)***	
Interviewer observations (ref = most favourable)			
Second			-0.10 (0.13)
Third			0.24 (0.13)
Fourth			0.35 (0.14)*
Least favourable			0.45 (0.15)***
Constant	2.20 (0.36)***	2.53 (0.38)***	2.73 (0.37)***
Between neighbourhood variance	0.16 (0.10)*	0.11 (0.10)^{NS}	0.13 (0.10)^{NS}
% of total neighbourhood variance explained	75.4	83.1	80.0
Within neighbourhood variance	11.68 (0.21)***	11.86 (0.21)***	11.84 (0.21)***
Total variance	11.84	11.97	11.97
Variance Partition Coefficient	1.4	0.9	1.1

*** p < 0.001 ** p < 0.01 *p < 0.05 ^{NS} Random effect not statistically significant

Appendix V Comparison between analysis samples for mother- and teacher-reported socio-emotional difficulties

Table 11-9 Comparison between analysis samples for mother and teacher reports of children's socio-emotional difficulties (cross-sectional analyses)

	Total difficulties, reported by the mother (N= 9,840)		Total difficulties, reported by the teacher (N= 6,450)	
	% of N	**Mean (SE)**	**% of N**	**Mean (SE)**
All	100	7.37 (0.08)	100	6.05 (0.09)
Child gender				
Boy	50.9	8.00 (0.10)	50.9	6.99 (0.12)
Girl	49.1	6.70 (0.09)	49.2	5.09 (0.11)
SEN statement				
No	92.4	6.92 (0.08)	92.5	5.56 (0.09)
Yes	7.6	12.33 (0.28)	7.5	11.60 (0.39)
Income quintile				
Top	19.6	5.48 (0.12)	21.0	4.89 (0.16)
Fourth	21.4	6.39 (0.13)	22.8	5.33 (0.15)
Third	21.4	7.30 (0.12)	21.7	5.98 (0.17)
Second	19.6	8.52 (0.16)	18.1	6.91 (0.22)
Bottom	17.9	9.63 (0.17)	16.4	7.76 (0.23)
NS-SEC (combined)				
Managerial / professional	42.3	6.06 (0.10)	44.5	5.10 (0.11)
Intermediate	11.7	7.02 (0.18)	12.0	5.76 (0.22)
Small empl. / self empl.	8.8	7.11 (0.18)	9.0	5.76 (0.25)
Lower supervisory / tech.	5.8	7.64 (0.28)	5.7	6.19 (0.32)
Semi routine / routine	14.2	8.66 (0.17)	13.2	7.16 (0.24)
Not applicable	17.1	9.74 (0.19)	15.5	8.02 (0.25)
Housing tenure				
Own / mortgage	71.0	6.49 (0.08)	72.5	5.40 (0.10)
Rent privately	5.8	8.48 (0.27)	5.9	7.08 (0.35)
Social housing	21.3	9.57 (0.17)	19.7	7.84 (0.21)
Other	1.9	8.17 (0.50)	1.9	5.52 (0.50)
Maternal age at interview				
40 plus	30.4	6.31 (0.11)	30.9	5.49 (0.14)
30 – 39	54.5	7.26 (0.09)	55.2	5.90 (0.11)
20 – 29	15.0	9.63 (0.18)	13.8	7.64 (0.24)
Maternal NVQ level				
Level 4/5	39.2	6.03 (0.10)	40.7	5.24 (0.11)

	Total difficulties, reported by the mother (N= 9,840)		Total difficulties, reported by the teacher (N= 6,450)	
	% of N	Mean (SE)	% of N	Mean (SE)
Level 3	15.7	7.21 (0.17)	15.7	5.94 (0.22)
Level 2	27.1	7.73 (0.13)	26.8	6.33 (0.16)
Level 1	7.0	8.96 (0.28)	6.7	6.99 (0.38)
Overseas only	2.1	9.19 (0.49)	1.9	6.48 (0.64)
None	8.9	10.10 (0.25)	8.2	7.99 (0.33)
Family structure				
Both natural parents	83.2	6.85 (0.08)	76.5	5.46 (0.10)
Natural mother / other partner	2.2	9.41 (0.47)	5.2	8.19 (0.43)
Single mother	14.6	9.32 (0.20)	18.3	7.67 (0.23)
Child ethnicity				
White	87.9	7.26 (0.08)	89.8	6.03 (0.10)
Mixed	2.3	8.14 (0.43)	2.1	6.30 (0.51)
Indian	2.2	7.49 (0.52)	2.0	5.13 (0.66)
Pakistani	2.9	9.56 (0.33)	2.4	6.98 (0.73)
Bangladeshi	1.0	9.32 (0.50)	0.6	4.09 (0.67)
Black Caribbean	1.1	8.05 (0.48)	0.9	7.87 (0.95)
Black African	1.3	6.81 (0.69)	1.1	6.91 (0.82)
Other (incl. Chinese)	1.2	8.21 (0.62)	1.1	5.24 (0.64)
Moved before sweep 3				
No	54.5	6.96 (0.09)	53.5	5.69 (0.12)
Yes	45.5	7.83 (0.11)	46.5	6.44 (0.13)
MCS stratum				
England – advantaged	28.8	6.83 (0.13)	30.7	5.69 (0.15)
England – disadvantaged	23.6	8.33 (0.13)	22.8	6.83 (0.16)
England – ethnic	8.5	8.84 (0.26)	6.8	6.77 (0.30)
Wales – advantaged	5.1	6.41 (0.26)	4.9	5.63 (0.39)
Wales – disadvantaged	10.6	7.97 (0.23)	10.0	6.59 (0.28)
Scotland – advantaged	6.5	6.42 (0.33)	7.0	5.58 (0.31)
Scotland – disadvantaged	5.9	7.75 (0.34)	5.9	5.92 (0.41)
NI – advantaged	4.5	6.37 (0.30)	5.5	5.48 (0.36)
NI – disadvantaged	6.7	7.82 (0.25)	6.5	6.70 (0.33)

Appendix VI Cross-sectional analyses of socio-emotional difficulties as reported by the mother and the teacher, full tables including parenting behaviours

Table 11-10 Results of cross-classified multilevel models predicting total socio-emotional difficulties as reported by the mother, cross-sectional analysis (N = 9,840)

	Estimate (Standard Deviation)	
	Model E	**Model F**
MCS stratum (ref = England - advantaged)		
England – disadvantaged	0.10 (0.14)	0.10 (0.14)
England – ethnic	0.34 (0.24)	0.38 (0.24)
Wales – advantaged	-0.43 (0.23)*	-0.44 (0.23)*
Wales – disadvantaged	-0.19 (0.18)	-0.15 (0.18)
Scotland – advantaged	-0.51 (0.22)*	-0.52 (0.22)*
Scotland – disadvantaged	-0.29 (0.23)	-0.28 (0.23)
NI – advantaged	-0.60 (0.27)*	-0.74 (0.27)**
NI – disadvantaged	-0.32 (0.24)	-0.42 (0.24)*
Girl	-0.97 (0.09)***	-0.94 (0.09)***
Child age in months	-0.05 (0.02)**	-0.05 (0.02)**
Has SEN statement	4.62 (0.18)***	4.62 (0.17)***
Weekly family income per £100	-0.10 (0.03)***	-0.09 (0.03)**
NS-SEC (ref= manag. / prof.)		
Intermediate	0.11 (0.16)	0.04 (0.16)
Small empl. / self empl.	0.33 (0.18)*	0.24 (0.18)
Lower supervisory / tech.	0.19 (0.22)	0.21 (0.21)
Semi routine / routine	0.74 (0.16)***	0.69 (0.16)***
No parent in work	0.53 (0.18)**	0.55 (0.18)**
Housing tenure (ref= owner)		
Rented privately	0.16 (0.22)	0.23 (0.21)
Social housing	0.56 (0.16)***	0.58 (0.16)***
Other	0.24 (0.34)	0.19 (0.34)
Maternal age (years)	-0.07 (0.01)***	-0.07 (0.01)***
Maternal NVQ (ref = level 4/5)		
Level 3	0.12 (0.14)	0.08 (0.14)
Level 2	0.36 (0.13)**	0.28 (0.13)*
Level 1	0.81 (0.21)***	0.69 (0.20)**
Overseas only	1.19 (0.34)***	1.06 (0.33)**
None	1.32 (0.20)***	1.25 (0.19)***
Number of siblings (ref = none)	-0.18 (0.05)***	-0.19 (0.05)***

Table 11-10 (continued)

	Estimate (Standard Deviation)	
	Model E	Model F
Family structure (ref = both natural parents)		
Natural mother / other partner	0.96 (0.22)***	1.01 (0.22)***
Single mother	0.11 (0.14)	0.17 (0.14)
Child ethnicity (ref = White)		
Mixed	-0.04 (0.31)	-0.18 (0.31)
Indian	0.24 (0.35)	0.19 (0.34)
Pakistani	0.78 (0.32)**	0.77 (0.32)**
Bangladeshi	0.92 (0.50)*	0.98 (0.49)*
Black Caribbean	-0.10 (0.46)	-0.42 (0.45)
Black African	-1.76 (0.43)***	-2.07 (0.42)***
Other (incl. Chinese)	0.36 (0.44)	0.20 (0.43)
Moved before sweep three	0.10 (0.10)	0.11 (0.10)
Neither friends nor family in the area	0.76 (0.25)**	0.75 (0.24)**
Neighbourhood and school level		
Rural (ref = urban)	-0.01 (0.12)	-0.01 (0.12)
Median household income, per £1000	-0.01 (0.01)	-0.01 (0.01)
% Social housing, per 10%	0.07 (0.03)*	0.07 (0.03)*
No park/playground in the area	0.24 (0.15)	0.19 (0.15)
School fees applicable	-0.35 (0.30)	-0.31 (0.30)
Maternal distress (Kessler-6, continuous)	0.39 (0.01)***	0.38 (0.01)***
Not read to daily/almost daily		0.02 (0.09)
No regular bedtime		0.99 (0.16)***
Mother used smacking		1.31 (0.09)***
Constant	12.81 (1.47)	12.04 (1.46)
Neighbourhood variance	0.12 (0.13)^{NS}	0.21 (0.15)^{NS}
% of total neighbourhood variance explained	90.3	83.1
School variance	0.04 (0.08)^{NS}	0.05 (0.06)^{NS}
% of total school variance explained	97.4	96.8
Residual variance	20.47 (0.32)	19.88 (0.33)
Total unexplained variance	20.63	20.14
% of unexplained variance due to neighbourhoods	0.6	1.0
% of unexplained variance due to schools	0.2	0.2
Bayesian DIC (smaller is better)	57,752	57,514

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ ^{NS} Random effect not statistically significant

Table 11-11 Results of cross-classified multilevel models predicting total socio-emotional difficulties as reported by the teacher, cross-sectional analysis (N = 6,450)

	Estimate (Standard Deviation)	
	Model H	**Model I**
MCS stratum (ref = England - advantaged)		
England – disadvantaged	0.24 (0.21)	0.23 (0.21)
England – ethnic	0.59 (0.36)*	0.62 (0.35)*
Wales – advantaged	-0.11 (0.35)	-0.12 (0.34)
Wales – disadvantaged	0.10 (0.28)	0.13 (0.27)
Scotland – advantaged	-0.33 (0.32)	-0.33 (0.32)
Scotland – disadvantaged	-0.56 (0.34)	-0.51 (0.34)
NI – advantaged	-0.19 (0.37)	-0.31 (0.37)
NI – disadvantaged	-0.19 (0.36)	-0.29 (0.36)
Girl	-1.62 (0.13)***	-1.61 (0.13)***
Child age in months	-0.10 (0.02)***	-0.10 (0.02)***
Has SEN statement	5.16 (0.24)***	5.13 (0.24)***
Weekly family income per £100	-0.02 (0.04)	-0.02 (0.04)
NS-SEC (ref= manag. / prof.)		
Intermediate	0.23 (0.21)	0.19 (0.21)
Small empl. / self empl.	0.72 (0.24)**	0.68 (0.24)**
Lower supervisory / tech.	0.50 (0.29)*	0.49 (0.29)*
Semi routine / routine	0.85 (0.23)***	0.81 (0.23)***
No parent in work	0.87 (0.25)***	0.88 (0.25)***
Housing tenure (ref= owner)		
Rented privately	0.50 (0.29)*	0.54 (0.29)*
Social housing	0.49 (0.23)*	0.49 (0.22)*
Other	-0.24 (0.47)	-0.30 (0.47)
Maternal age (years)	-0.01 (0.01)	-0.01 (0.01)
Maternal NVQ (ref = level 4/5)		
Level 3	-0.04 (0.19)	-0.07 (0.19)
Level 2	0.03 (0.17)	0.00 (0.17)
Level 1	0.28 (0.28)	0.23 (0.28)
Overseas only	-0.16 (0.47)	-0.30 (0.47)
None	1.09 (0.27)***	1.04 (0.27)***
Number of siblings (ref = none)	-0.27 (0.07)***	-0.26 (0.07)***
Family structure (ref = both natural parents)		
Natural mother / other partner	1.47 (0.30)***	1.56 (0.30)***
Single mother	0.82 (0.20)***	0.87 (0.20)***

Table 11-11 (continued)

	Estimate (Standard Deviation)	
	Model H	**Model I**
Child ethnicity (ref = White)		
Mixed	-0.14 (0.44)	-0.25 (0.44)
Indian	-0.91 (0.50)*	-0.84 (0.49)*
Pakistani	0.33 (0.49)	0.35 (0.49)
Bangladeshi	-2.15 (0.87)**	-2.02 (0.87)*
Black Caribbean	0.65 (0.69)	0.44 (0.68)
Black African	-0.23 (0.65)	-0.42 (0.64)
Other (incl. Chinese)	-1.74 (0.63)**	-1.80 (0.62)**
Moved before sweep three	0.11 (0.13)	0.11 (0.13)
Neither friends nor family in the area	1.30 (0.33)***	1.29 (0.33)***
Neighbourhood and school level		
Rural (ref = urban)	0.08 (0.17)	0.07 (0.17)
Median household income, per £1000	-0.01 (0.01)	-0.01 (0.01)
% Social housing, per 10%	0.10 (0.05)*	0.10 (0.05)*
No park/playground in the area	0.28 (0.21)	0.25 (0.21)
School fees applicable	1.00 (0.40)**	0.98 (0.40)**
Maternal distress (Kessler-6, continuous)	0.12 (0.02)***	0.11 (0.02)***
Not read to daily/almost daily		-0.30 (0.13)**
No regular bedtime		0.63 (0.22)**
Mother used smacking		0.79 (0.13)***
Constant	14.65 (2.07)	14.23 (2.06)
Neighbourhood variance	0.09 (0.12)[NS]	0.03 (0.07)[NS]
% of total neighbourhood variance explained	89.7	96.6
School variance	0.76 (0.42)[NS]	0.60 (0.45)[NS]
% of total school variance explained	20.8	37.5
Teacher variance	2.98 (0.59)	3.25 (0.61)
% of total teacher variance explained	26.2	19.6
Residual variance	21.68 (0.54)	21.47 (0.53)
Total unexplained variance	25.51	25.35
% of unexplained variance due to neighbourhoods	0.4	0.1
% of unexplained variance due to schools	3.0	2.4
% of unexplained variance due to teachers	11.7	12.8
Bayesian DIC (smaller is better)	39,002	38,953

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ [NS] Random effect not statistically significant

Appendix VII Longitudinal analyses of socio-emotional difficulties as reported by the mother and the teacher – full tables

Table 11-12 Cross-classified multilevel models predicting mother-reported total socio-emotional difficulties at age 7, longitudinal analysis (N= 6,668)

	Estimate (Standard Deviation)				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)					
England – disadvantaged	0.20 (0.17)	-0.02 (0.18)	-0.01 (0.17)	0.03 (0.18)	0.02 (0.17)
England – ethnic	0.42 (0.32)	0.08 (0.33)	0.16 (0.32)	0.14 (0.33)	0.17 (0.32)
Wales – advantaged	-0.47 (0.27)*	-0.35 (0.27)	-0.35 (0.27)	-0.47 (0.27)*	-0.44 (0.27)*
Wales – disadvantaged	0.07 (0.21)	-0.03 (0.23)	-0.05 (0.22)	-0.06 (0.23)	-0.08 (0.22)
Scotland – advantaged	-0.43 (0.25)*	-0.31 (0.28)	-0.21 (0.27)	-0.39 (0.28)	-0.26 (0.27)
Scotland – disadvantaged	0.12 (0.28)	-0.12 (0.30)	0.01 (0.29)	-0.06 (0.30)	0.07 (0.29)
NI – advantaged	-0.80 (0.29)**	-0.64 (0.33)*	-0.43 (0.32)	-0.71 (0.33)*	-0.47 (0.32)
NI – disadvantaged	-0.10 (0.27)	-0.16 (0.31)	-0.06 (0.30)	-0.26 (0.31)	-0.13 (0.30)
Girl	-1.07 (0.12)***	-1.06 (0.11) ***	-1.02 (0.11)***	-1.06 (0.11)***	-1.02 (0.11)***
Child age in months	-0.04 (0.02)*	-0.05 (0.02)**	-0.05 (0.02)**	-0.05 (0.02)*	-0.05 (0.02)**
Has SEN statement	4.89 (0.22)***	4.84 (0.22) ***	4.63 (0.21)***	4.85 (0.22)***	4.62 (0.21)***
Weekly family income per £100	-0.17 (0.03)***	-0.14 (0.04)***	-0.08 (0.03)**	-0.13 (0.04)***	-0.08 (0.03)*
NS-SEC (ref= manag. / prof.)					
Intermediate	-0.02 (0.19)	-0.04 (0.19)	-0.01 (0.19)	-0.06 (0.19)	-0.03 (0.19)
Small empl. / self empl.	0.20 (0.22)	0.20 (0.22)	0.26 (0.22)	0.16 (0.22)	0.22 (0.22)
Lower supervisory / tech.	0.35 (0.27)	0.31 (0.26)	0.32 (0.26)	0.24 (0.26)	0.27 (0.26)
Semi routine / routine	0.89 (0.21)***	0.82 (0.21)***	0.81 (0.20)***	0.76 (0.21)***	0.75 (0.20)***
No parent in work	1.00 (0.23)***	1.00 (0.23)***	0.75 (0.23)***	0.94 (0.23)***	0.70 (0.23)**
Housing tenure (ref= owner)					
Rented privately	0.08 (0.31)	0.08 (0.31)	-0.05 (0.30)	-0.02 (0.31)	-0.13 (0.30)
Social housing	0.93 (0.20)***	0.63 (0.21)**	0.47 (0.20)*	0.63 (0.21)**	0.44 (0.20)*
Other	0.12 (0.44)	0.04 (0.43)	0.17 (0.42)	0.11 (0.43)	0.23 (0.42)

Table 11-12 (continued)

	Estimate (Standard Deviation)				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
Maternal age (years)	-0.07 (0.01)***	-0.06 (0.01)***	-0.07 (0.01)***	-0.06 (0.01)***	-0.07 (0.01)***
Maternal NVQ (ref = level 4/5)					
Level 3	0.01 (0.18)	-0.02 (0.17)	-0.01 (0.17)	0.00 (0.18)	0.00 (0.17)
Level 2	0.38 (0.16)**	0.33 (0.16)*	0.35 (0.15)*	0.34 (0.16)*	0.36 (0.15)**
Level 1	0.55 (0.26)*	0.51 (0.26)*	0.68 (0.25)**	0.48 (0.26)*	0.66 (0.25)**
Overseas only	1.71 (0.47)***	1.68 (0.47)***	1.59 (0.45)***	1.70 (0.47)***	1.60 (0.45)***
None	1.40 (0.26)***	1.34 (0.26)***	1.25 (0.25)***	1.30 (0.26)***	1.22 (0.25)***
Number of siblings (ref = none)	-0.22 (0.06)***	-0.22 (0.06)***	-0.21 (0.06)***	-0.22 (0.06)***	-0.22 (0.06)***
Family structure (ref = both natural parents)					
Natural mother / other partner	1.06 (0.31)***	1.04 (0.31)***	0.82 (0.30)**	1.03 (0.31)***	0.79 (0.30)**
Single mother	0.44 (0.19)**	0.43 (0.19)*	0.26 (0.18)	0.42 (0.19)*	0.25 (0.18)
Child ethnicity (ref = White)					
Mixed	0.67 (0.40)*	0.59 (0.40)	0.54 (0.38)	0.60 (0.40)	0.54 (0.38)
Indian	-0.24 (0.49)	-0.17 (0.49)	-0.38 (0.48)	-0.25 (0.49)	-0.44 (0.48)
Pakistani	0.97 (0.49)*	1.11 (0.49)*	0.87 (0.47)*	0.95 (0.49)*	0.73 (0.47)
Bangladeshi	0.11 (0.90)	0.07 (0.89)	0.01 (0.86)	0.07 (0.89)	0.03 (0.87)
Black Caribbean	0.06 (0.62)	-0.01 (0.62)	-0.07 (0.60)	0.04 (0.62)	-0.04 (0.60)
Black African	-1.43 (0.76)*	-1.69 (0.76)*	-1.66 (0.72)*	-1.80 (0.76)**	-1.75 (0.72)**
Other (incl. Chinese)	0.66 (0.71)	0.62 (0.71)	0.45 (0.68)	0.58 (0.72)	0.42 (0.69)
Rural (ref = urban)		0.17 (0.15)	0.17 (0.14)	0.07 (0.15)	0.11 (0.14)
Median household income, per £1000		0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
School fees applicable		-0.34 (0.38)	-0.32 (0.37)	-0.28 (0.38)	-0.27 (0.37)

Table 11-12 (continued)

	Estimate (Standard Deviation)				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
% Social housing, per 10%		0.06 (0.04)	0.05 (0.04)	0.07 (0.04)*	0.05 (0.04)
Neither friends nor family in the area		1.05 (0.34)**	0.81 (0.33)**	1.16 (0.34)***	0.89 (0.33)**
No park/playground in the area		0.29 (0.19)	0.19 (0.19)	0.33 (0.19)*	0.21 (0.19)
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Fourth		0.64 (0.17)***	0.52 (0.17)**		
Third		0.84 (0.18)***	0.62 (0.17)***		
Second		1.24 (0.19)***	0.94 (0.18)***		
Least satisfied		1.51 (0.22)***	0.99 (0.21)***		
Interviewer observations sweep two (ref = most favourable)					
Fourth				-0.03 (0.18)	-0.04 (0.17)
Third				0.66 (0.18)***	0.52 (0.18)**
Second				0.60 (0.20)**	0.41 (0.19)*
Least favourable				0.90 (0.22)***	0.75 (0.21)***
Maternal psychological distress over time (ref = none)					
Current (sweep four)			2.61 (0.16)***		2.65 (0.16)***
Past (sweep two and/or sweep three only)			0.99 (0.15)***		1.02 (0.15)***
Persistent (sweeps two, three and four)			3.49 (0.18)***		3.56 (0.18)***
Between neighbourhood variance	0.13 (0.15)^{NS}	0.07 (0.09)^{NS}	0.02 (0.04)^{NS}	0.06 (0.08)^{NS}	0.02 (0.04)^{NS}
Between school variance	0.24 (0.20)^{NS}	0.26 (0.20)^{NS}	0.33 (0.18)	0.24 (0.19)^{NS}	0.32 (0.18)
Residual variance	21.45 (0.42)	21.25 (0.43)	19.64 (0.39)	21.39 (0.43)	19.69 (0.39)
Bayesian DIC (smaller is better)	39,512	39,445	38,937	39,478	38,949

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ ^{NS} Random effect not statistically significant

Table 11-13 Cross-classified multilevel models predicting teacher-reported total socio-emotional difficulties at age 7, longitudinal analysis (N= 4,414)

	Estimate (Standard Deviation)				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)					
England – disadvantaged	0.29 (0.23)	0.14 (0.24)	0.12 (0.24)	0.16 (0.24)	0.13 (0.24)
England – ethnic	1.10 (0.46)**	0.96 (0.46)*	0.98 (0.46)*	0.91 (0.46)*	0.92 (0.46)*
Wales – advantaged	-0.18 (0.39)	-0.20 (0.40)	-0.22 (0.39)	-0.19 (0.40)	-0.19 (0.39)
Wales – disadvantaged	0.40 (0.30)	0.26 (0.32)	0.26 (0.31)	0.24 (0.32)	0.26 (0.32)
Scotland – advantaged	-0.19 (0.34)	-0.34 (0.38)	-0.30 (0.37)	-0.26 (0.38)	-0.21 (0.37)
Scotland – disadvantaged	-0.14 (0.37)	-0.50 (0.41)	-0.45 (0.41)	-0.43 (0.42)	-0.37 (0.41)
NI – advantaged	-0.23 (0.38)	-0.42 (0.43)	-0.36 (0.43)	-0.29 (0.43)	-0.22 (0.43)
NI – disadvantaged	0.01 (0.37)	-0.34 (0.43)	-0.33 (0.43)	-0.29 (0.43)	-0.26 (0.43)
Girl	-1.70 (0.15)***	-1.69 (0.15)***	-1.69 (0.15)***	-1.68 (0.15)***	-1.68 (0.15)***
Child age in months	-0.11 (0.03)***	-0.11 (0.03)***	-0.11 (0.03)***	-0.11 (0.03)***	-0.11 (0.03)***
Has SEN statement	5.35 (0.29)***	5.32 (0.29)***	5.25 (0.29)***	5.28 (0.29)***	5.21 (0.29)***
Weekly family income per £100	-0.03 (0.04)	-0.04 (0.05)	-0.02 (0.05)	-0.03 (0.05)	-0.01 (0.05)
NS-SEC (ref= manag. / prof.)					
Intermediate	0.26 (0.25)	0.26 (0.25)	0.27 (0.25)	0.25 (0.25)	0.26 (0.25)
Small empl. / self empl.	0.60 (0.28)*	0.54 (0.29)*	0.56 (0.28)*	0.52 (0.29)*	0.53 (0.28)*
Lower supervisory / tech.	0.66 (0.35)*	0.61 (0.35)*	0.58 (0.35)*	0.59 (0.35)*	0.56 (0.35)*
Semi routine / routine	1.12 (0.27)***	1.02 (0.27)***	1.01 (0.27)***	0.98 (0.27)***	0.97 (0.27)***
No parent in work	0.94 (0.30)**	0.88 (0.31)**	0.79 (0.31)**	0.85 (0.31)**	0.76 (0.31)**
Housing tenure (ref= owner)					
Rented privately	0.53 (0.41)	0.45 (0.40)	0.43 (0.40)	0.38 (0.40)	0.37 (0.40)
Social housing	0.47 (0.26)*	0.23 (0.28)	0.19 (0.28)	0.18 (0.28)	0.14 (0.28)
Other	-0.14 (0.58)	-0.13 (0.58)	-0.11 (0.57)	-0.13 (0.57)	-0.11 (0.57)

Table 11-13 (continued)

	Estimate (Standard Deviation)				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
Maternal age (years)	-0.02 (0.02)	-0.02 (0.02)	-0.02 (0.02)	-0.01 (0.02)	-0.02 (0.02)
Maternal NVQ (ref = level 4/5)					
Level 3	-0.02 (0.22)	-0.02 (0.22)	-0.03 (0.22)	-0.01 (0.22)	-0.02 (0.22)
Level 2	0.12 (0.20)	0.11 (0.20)	0.12 (0.20)	0.12 (0.20)	0.12 (0.20)
Level 1	0.25 (0.33)	0.24 (0.33)	0.28 (0.33)	0.21 (0.33)	0.24 (0.33)
Overseas only	-0.03 (0.63)	-0.02 (0.63)	-0.03 (0.63)	0.02 (0.63)	0.00 (0.63)
None	0.96 (0.35)**	0.91 (0.35)**	0.88 (0.35)**	0.87 (0.35)**	0.84 (0.35)**
Number of siblings (ref = none)	-0.36 (0.08)***	-0.37 (0.08)***	-0.37 (0.08)***	-0.37 (0.08)***	-0.37 (0.08)***
Family structure (ref = both natural parents)					
Natural mother / other partner	1.37 (0.41)***	1.35 (0.41)***	1.27 (0.41)**	1.32 (0.41)**	1.24 (0.41)**
Single mother	0.95 (0.24)***	0.94 (0.24)***	0.89 (0.24)***	0.92 (0.24)***	0.87 (0.24)***
Child ethnicity (ref = White)					
Mixed	-0.21 (0.55)	-0.19 (0.54)	-0.22 (0.54)	-0.21 (0.54)	-0.25 (0.54)
Indian	-1.12 (0.67)*	-1.16 (0.67)*	-1.24 (0.67)*	-1.24 (0.67)*	-1.33 (0.67)*
Pakistani	0.04 (0.70)	-0.04 (0.70)	-0.17 (0.70)	-0.07 (0.70)	-0.19 (0.70)
Bangladeshi	-1.46 (1.44)	-1.59 (1.43)	-1.70 (1.43)	-1.53 (1.43)	-1.65 (1.43)
Black Caribbean	0.93 (0.84)	0.89 (0.84)	0.89 (0.83)	0.91 (0.84)	0.91 (0.83)
Black African	-1.49 (1.02)	-1.89 (1.03)*	-1.89 (1.03)*	-2.01 (1.03)*	-2.01 (1.03)*
Other (incl. Chinese)	-1.91 (0.92)*	-1.81 (0.92)*	-1.87 (0.93)*	-1.85 (0.92)*	-1.91 (0.93)*
Rural (ref = urban)		0.19 (0.20)	0.18 (0.20)	0.25 (0.20)	0.25 (0.20)
Median household income, per £1000		-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
School fees applicable		1.65 (0.48)***	1.65 (0.48)***	1.67 (0.48)***	1.66 (0.48)***

Table 11-13 (continued)

	Estimate (Standard Deviation)				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
% Social housing, per 10%		0.08 (0.06)	0.08 (0.06)	0.07 (0.06)	0.06 (0.06)
Neither friends nor family in the area		1.69 (0.44)***	1.65 (0.44)***	1.69 (0.44)***	1.65 (0.44)***
No park/playground in the area		0.19 (0.25)	0.17 (0.25)	0.19 (0.25)	0.16 (0.25)
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Fourth		-0.06 (0.22)	-0.10 (0.22)		
Third		0.13 (0.23)	0.06 (0.23)		
Second		0.06 (0.24)	-0.04 (0.24)		
Least satisfied		0.31 (0.28)	0.13 (0.28)		
Interviewer observations sweep two (ref = most favourable)					
Fourth				0.44 (0.22)*	0.45 (0.22)*
Third				0.69 (0.23)**	0.66 (0.23)**
Second				0.61 (0.26)**	0.55 (0.26)*
Least favourable				0.90 (0.29)**	0.85 (0.29)**
Maternal psychological distress over time (ref = none)					
Current (sweep four)			0.83 (0.21)***		0.82 (0.21)***
Past (sweep two and/or sweep three only)			0.48 (0.20)**		0.48 (0.20)**
Persistent (sweeps two, three and four)			1.03 (0.24)***		1.03 (0.24)***
Between neighbourhood variance	0.07 (0.14)[NS]	0.10 (0.11)[NS]	0.08 (0.07)[NS]	0.09 (0.10)[NS]	0.07 (0.07)[NS]
Between school variance	0.78 (0.54)[NS]	0.75 (0.55)[NS]	0.45 (0.51)[NS]	0.88 (0.57)[NS]	0.53 (0.57)[NS]
Between teacher variance	3.16 (0.78)	3.19 (0.82)	3.46 (0.76)	3.11 (0.82)	3.43 (0.80)
Residual variance	20.50 (0.66)	20.33 (0.66)	20.24 (0.65)	20.24 (0.66)	20.15 (0.65)
Bayesian DIC (smaller is better)	26,502	26,482	26,461	26,469	26,448

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ [NS] Random effect not statistically significant

Appendix VIII Cross-sectional analyses of cognitive test performance, full tables including child behaviour and parenting practices

Table 11-14 Results of cross-classified multilevel models predicting reading test performance, cross-sectional analysis (N = 9,412)

	Estimate (Standard Deviation)[1]		
	Model E	**Model F**	**Model G**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	2.78 (3.02)	3.15 (3.02)	3.28 (2.99)
England – ethnic	18.51 (4.96)***	19.47 (4.92)***	19.63 (4.90)***
Wales – advantaged	-19.94 (5.19)***	-21.01 (5.15)***	-20.86 (5.16)***
Wales – disadvantaged	-28.54 (4.08)***	-29.15 (4.04)***	-29.16 (4.06)***
Scotland – advantaged	5.41 (5.22)	4.55 (5.20)	4.43 (5.18)
Scotland – disadvantaged	4.79 (5.08)	4.60 (5.07)	4.34 (5.06)
NI – advantaged	-18.61 (6.09)**	-19.73 (5.98)**	-18.58 (6.01)**
NI – disadvantaged	-20.31 (5.16)***	-20.81 (5.13)***	-19.90 (5.10)***
Child and family level			
Girl	11.25 (1.82)***	8.25 (1.81)***	8.38 (1.81)***
Child age in months	-2.32 (0.32)***	-2.47 (0.32)***	-2.50 (0.32)***
Has SEN statement	-77.66 (3.63)***	-64.49 (3.69)***	-64.29 (3.69)***
Weekly family income per £100	2.33 (0.58)***	2.09 (0.57)***	2.07 (0.56)***
NS-SEC (ref= manag. / prof.)			
Intermediate	-9.32 (3.13)**	-9.08 (3.10)**	-9.02 (3.10)**
Small empl. / self empl.	-12.23 (3.55)***	-11.34 (3.50)**	-11.16 (3.51)**
Lower supervisory / tech.	-10.17 (4.25)**	-10.01 (4.17)**	-9.65 (4.14)*
Semi routine / routine	-18.59 (3.25)***	-16.36 (3.22)***	-16.08 (3.22)***
No parent in work	-14.61 (3.60)***	-13.20 (3.55)***	-12.84 (3.55)***
Housing tenure (ref= owner)			
Rented privately	-4.37 (4.26)	-3.38 (4.23)	-3.48 (4.22)
Social housing	-14.15 (3.05)***	-11.82 (3.00)***	-11.48 (3.00)***
Other	7.25 (6.85)	8.30 (6.77)	8.70 (6.79)
Maternal age (years)	0.43 (0.19)*	0.21 (0.18)	0.27 (0.18)
Maternal NVQ (ref = level 4/5)			
Level 3	-5.67 (2.83)*	-5.46 (2.81)*	-5.42 (2.81)*
Level 2	-11.89 (2.54)***	-10.88 (2.50)***	-11.11 (2.50)***
Level 1	-30.30 (4.05)***	-28.14 (4.02)***	-28.32 (4.00)***
Overseas only	-23.47 (6.70)***	-20.09 (6.62)**	-19.94 (6.61)**
None	-37.10 (3.89)***	-33.23 (3.87)***	-33.29 (3.88)***
Number of siblings (ref = none)	-6.61 (0.95)***	-7.09 (0.94)***	-7.37 (0.94)***

Table 11-14 (continued)

	Estimate (Standard Deviation)[1]		
	Model E	**Model F**	**Model G**
Family structure (ref = both natural parents)			
Natural mother / other partner	-12.59 (4.34)**	-9.32 (4.30)*	-10.18 (4.29)**
Single mother	-5.24 (2.86)*	-4.92 (2.82)*	-5.27 (2.81)*
Child ethnicity (ref = White)			
Mixed	9.59 (6.14)	9.33 (6.09)	9.38 (6.09)
Indian	19.29 (7.76)**	20.35 (7.61)**	19.83 (7.65)**
Pakistani	18.60 (7.43)**	20.69 (7.37)**	20.31 (7.37)**
Bangladeshi	21.83 (10.68)*	24.64 (10.52)*	23.44 (10.57)*
Black Caribbean	-7.23 (8.94)	-7.14 (8.88)	-7.16 (8.91)
Black African	32.01 (8.66)***	27.53 (8.60)**	27.90 (8.56)**
Other (incl. Chinese)	9.31 (9.20)	10.66 (9.08)	10.91 (9.03)
Neighbourhood and school level			
Rural (ref = urban)	-6.40 (2.52)**	-6.21 (2.50)**	-6.07 (2.50)**
Median household income, per £1000	0.77 (0.20)***	0.78 (0.20)***	0.81 (0.20)***
IMD education domain, per decile (ref=most deprived)	0.61 (0.61)	0.34 (0.61)	0.28 (0.61)
School fees applicable	13.57 (6.06)*	12.38 (6.01)*	12.88 (5.95)*
Maternal distress (Kessler-6 score)	-0.71 (0.25)**	0.47 (0.26)*	0.46 (0.26)*
Child behaviour (Total Difficulties score)		-3.03 (0.20)***	-2.98 (0.20)***
Mother reads daily			-6.76 (1.85)***
No regular bedtime			-9.62 (3.13)**
Smacking			-1.08 (1.82)
Constant	207.39 (29.32)	248.41 (29.07)	252.55 (29.09)
Neighbourhood variance	11.43 (22.95)^{NS}	9.66 (20.29)^{NS}	4.27 (23.80)^{NS}
% of total neighbourhood variance explained	97.8	98.1	99.2
School variance	489.68 (78.11)	511.39 (79.53)	523.87 (77.32)
% of total school variance explained	50.5	51.7	47.1
Residual variance	7,266.36 (123.27)	7,065.42 (121.55)	7,046.46 (120.44)
Total unexplained variance	7,767.47	7,577.47	7,574.60
% of unexplained variance due to neighbourhoods	0.1	0.1	0.1
% of unexplained variance due to schools	6.3	6.7	6.9
Bayesian DIC (smaller is better)	110,931	110,693	110,677

*** p < 0.001   ** p < 0.01   *p < 0.05 ^{NS} Random effect not statistically significant

[1] Covariates include school year and language spoken in the home (data not shown)

Table 11-15 Results of cross-classified multilevel models predicting maths test performance, cross-sectional analysis (N = 9,412)

	Estimate (Standard Deviation)[1]		
	Model E	**Model F**	**Model G**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	4.97 (3.39)	5.33 (3.37)	5.44 (3.34)
England – ethnic	15.70 (5.41)**	16.44 (5.38)**	16.54 (5.35)**
Wales – advantaged	6.55 (5.97)	5.73 (5.90)	5.59 (5.94)
Wales – disadvantaged	1.72 (4.66)	1.22 (4.63)	1.09 (4.63)
Scotland – advantaged	-5.15 (5.86)	-6.05 (5.82)	-6.27 (5.80)
Scotland – disadvantaged	-2.68 (5.65)	-2.92 (5.61)	-3.17 (5.63)
NI – advantaged	4.06 (7.07)	3.12 (6.94)	3.38 (6.98)
NI – disadvantaged	19.27 (6.03)**	19.04 (5.96)**	19.32 (5.93)**
Child and family level			
Girl	-7.82 (1.87)***	-10.64 (1.88)***	-10.57 (1.86)***
Child age in months	-3.38 (0.34)***	-3.53 (0.33)***	-3.56 (0.33)***
Has SEN statement	-65.57 (3.76)***	-53.11 (3.82)***	-52.79 (3.82)***
Weekly family income per £100	2.24 (0.60)***	2.00 (0.59)***	2.01 (0.58)***
NS-SEC (ref= manag. / prof.)			
Intermediate	-9.66 (3.23)**	-9.42 (3.20)**	-9.49 (3.21)**
Small empl. / self empl.	-11.72 (3.65)***	-10.96 (3.62)**	-11.07 (3.63)**
Lower supervisory / tech.	-13.16 (4.38)**	-13.18 (4.31)**	-12.89 (4.28)**
Semi routine / routine	-18.22 (3.35)***	-16.15 (3.34)***	-16.13 (3.33)***
No parent in work	-11.64 (3.73)**	-10.41 (3.68)**	-10.14 (3.69)**
Housing tenure (ref= owner)			
Rented privately	-5.62 (4.42)	-4.59 (4.40)	-4.59 (4.40)
Social housing	-10.91 (3.18)***	-8.62 (3.14)**	-8.48 (3.14)**
Other	9.01 (7.07)	10.18 (6.98)	10.16 (7.02)
Maternal age (years)	0.04 (0.19)	-0.17 (0.19)	-0.14 (0.19)
Maternal NVQ (ref = level 4/5)			
Level 3	-7.65 (2.92)**	-7.46 (2.91)**	-7.46 (2.91)**
Level 2	-12.13 (2.63)***	-11.20 (2.59)***	-11.55 (2.60)***
Level 1	-22.97 (4.16)***	-21.03 (4.15)***	-21.43 (4.14)***
Overseas only	-15.20 (6.90)*	-12.03 (6.84)*	-12.37 (6.83)*
None	-31.76 (4.02)***	-28.17 (4.00)***	-28.77 (4.01)***
Number of siblings (ref = none)	-1.29 (0.99)	-1.73 (0.97)*	-1.92 (0.97)*

Table 11-15 (continued)

	Estimate (Standard Deviation)[1]		
	Model E	**Model F**	**Model G**
Family structure (ref = both natural parents)			
Natural mother / other partner	-4.74 (4.49)	-1.63 (4.45)	-1.99 (4.44)
Single mother	-1.80 (2.95)	-1.54 (2.91)	-1.64 (2.91)
Child ethnicity (ref = White)			
Mixed	0.56 (6.37)	0.20 (6.34)	-0.12 (6.31)
Indian	5.72 (8.17)	6.71 (8.01)	6.05 (8.07)
Pakistani	-22.92 (7.90)**	-20.87 (7.82)**	-21.28 (7.85)**
Bangladeshi	-31.10 (11.17)**	-28.51 (11.04)**	-29.13 (11.10)**
Black Caribbean	-14.66 (9.41)	-14.59 (9.38)	-15.33 (9.40)
Black African	-21.31 (9.10)*	-25.64 (9.05)**	-26.24 (9.02)**
Other (incl. Chinese)	-4.12 (9.54)	-2.85 (9.45)	-3.09 (9.43)
Neighbourhood and school level			
Rural (ref = urban)	1.37 (2.88)	1.53 (2.85)	1.65 (2.86)
Median household income, per £1000	0.52 (0.23)*	0.52 (0.22)*	0.53 (0.22)*
IMD education domain, per decile (ref=most deprived)	0.77 (0.69)	0.53 (0.67)	0.54 (0.68)
School fees applicable	11.63 (6.42)*	10.57 (6.37)*	11.08 (6.32)*
Maternal distress (Kessler-6 score)	-1.07 (0.26)***	0.04 (0.27)	0.00 (0.27)
Child behaviour (Total Difficulties score)		-2.84 (0.21)***	-2.86 (0.21)***
Mother reads daily			-5.40 (1.92)**
No regular bedtime			-0.41 (3.24)
Smacking			1.11 (1.89)
Constant	302.78 (30.57)	341.58 (30.32)	345.41 (30.40)
Neighbourhood variance	599.60 (102.72)	544.32 (105.10)	537.59 (105.72)
% of total neighbourhood variance explained	27.6	34.3	35.1
School variance	808.40 (109.93)	831.67 (109.19)	841.80 (107.02)
% of total school variance explained	27.2	25.1	24.2
Residual variance	7,117.51 (133.83)	6,981.75 (133.42)	6,975.29 (132.17)
Total unexplained variance	8,525.51	8,357.74	8,354.68
% of unexplained variance due to neighbourhoods	7.0	6.5	6.4
% of unexplained variance due to schools	9.5	10.0	10.1
Bayesian DIC (smaller is better)	114,431	111,242	111,238

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ [NS] Random effect not statistically significant

[1] Covariates include school year and language spoken in the home (data not shown)

Table 11-16 Results of cross-classified multilevel models predicting spatial ability (pattern construction) test performance, cross-sectional analysis (N = 9,412)

	Estimate (Standard Deviation)[1]		
	Model E	**Model F**	**Model G**
MCS stratum (ref = England - advantaged)			
England – disadvantaged	-5.61 (3.18)*	-5.36 (3.18)*	-5.17 (3.15)
England – ethnic	-7.20 (5.24)	-6.53 (5.23)	-6.29 (5.20)
Wales – advantaged	6.07 (5.46)	5.43 (5.43)	5.50 (5.45)
Wales – disadvantaged	3.58 (4.30)	3.23 (4.27)	3.28 (4.28)
Scotland – advantaged	3.45 (5.47)	2.80 (5.44)	2.67 (5.43)
Scotland – disadvantaged	-5.63 (5.33)	-5.73 (5.31)	-5.91 (5.32)
NI – advantaged	11.47 (6.53)*	10.79 (6.43)*	11.35 (6.44)*
NI – disadvantaged	1.41 (5.54)	1.04 (5.51)	1.45 (5.46)
Child and family level			
Girl	6.01 (1.93)**	3.86 (1.94)*	3.97 (1.93)*
Child age in months	0.89 (0.34)**	0.78 (0.34)*	0.75 (0.34)*
Has SEN statement	-50.42 (3.85)***	-40.96 (3.94)***	-40.60 (3.94)***
Weekly family income per £100	0.82 (0.61)	0.64 (0.61)	0.65 (0.60)
NS-SEC (ref= manag. / prof.)			
Intermediate	-10.24 (3.32)**	-10.08 (3.31)**	-10.20 (3.31)**
Small empl. / self empl.	-5.87 (3.76)	-5.29 (3.74)	-5.33 (3.75)
Lower supervisory / tech.	-4.10 (4.51)	-4.05 (4.45)	-3.77 (4.43)
Semi routine / routine	-15.49 (3.45)***	-13.91 (3.45)***	-13.78 (3.44)***
No parent in work	-10.00 (3.82)**	-8.98 (3.79)**	-8.65 (3.80)*
Housing tenure (ref= owner)			
Rented privately	-6.64 (4.52)	-5.93 (4.52)	-5.84 (4.52)
Social housing	-11.01 (3.24)***	-9.33 (3.21)**	-9.00 (3.20)**
Other	2.27 (7.26)	3.04 (7.22)	3.19 (7.26)
Maternal age (years)	0.02 (0.20)	-0.14 (0.20)	-0.08 (0.20)
Maternal NVQ (ref = level 4/5)			
Level 3	-4.98 (3.00)*	-4.81 (3.01)	-4.76 (3.01)
Level 2	-11.29 (2.70)***	-10.58 (2.68)***	-10.86 (2.68)***
Level 1	-19.32 (4.29)***	-17.76 (4.30)***	-18.04 (4.28)***
Overseas only	-26.32 (7.10)***	-23.91 (7.07)***	-23.85 (7.06)***
None	-30.03 (4.13)***	-27.31 (4.13)***	-27.46 (4.14)***
Number of siblings (ref = none)	-0.86 (1.01)	-1.20 (1.00)	-1.46 (1.00)

Table 11-16 (continued)

	Estimate (Standard Deviation)[1]		
	Model E	**Model F**	**Model G**
Family structure (ref = both natural parents)			
Natural mother / other partner	-1.29 (4.61)	1.13 (4.59)	0.64 (4.59)
Single mother	-2.69 (3.04)	-2.47 (3.01)	-2.63 (3.01)
Child ethnicity (ref = White)			
Mixed	-11.60 (6.52)*	-11.94 (6.50)*	-12.24 (6.50)*
Indian	-20.93 (8.22)**	-20.28 (8.10)**	-20.91 (8.13)**
Pakistani	-37.72 (7.86)***	-36.19 (7.82)***	-36.46 (7.83)***
Bangladeshi	-22.17 (11.29)*	-20.17 (11.21)*	-21.29 (11.28)*
Black Caribbean	-54.47 (9.49)***	-54.59 (9.50)***	-55.47 (9.52)***
Black African	-54.21 (9.18)***	-57.68 (9.17)***	-58.31 (9.14)***
Other (incl. Chinese)	-15.62 (9.75)	-14.80 (9.69)	-15.06 (9.66)
Neighbourhood and school level			
Rural (ref = urban)	-2.87 (2.67)	-2.75 (2.65)	-2.69 (2.65)
Median household income, per £1000	0.10 (0.22)	0.11 (0.22)	0.13 (0.22)
IMD education domain, per decile (ref=most deprived)	2.32 (0.66)***	2.12 (0.65)**	2.10 (0.65)**
School fees applicable	5.29 (6.38)	4.44 (6.36)	4.96 (6.30)
Maternal distress (Kessler-6 score)	-0.60 (0.27)*	0.24 (0.28)	0.23 (0.28)
Child behaviour (Total Difficulties score)		-2.17 (0.21)***	-2.18 (0.21)***
Mother reads daily			-5.69 (1.97)**
No regular bedtime			-5.78 (3.35)*
Smacking			1.58 (1.95)
Constant	-61.25 (31.10)	-31.89 (31.03)	-29.32 (31.05)
Neighbourhood variance	265.58 (83.90)	239.20 (91.99)	202.15 (106.51)
% of total neighbourhood variance explained	59.8	63.8	69.4
School variance	291.94 (83.15)	299.79 (90.94)	325.72 (88.35)
% of total school variance explained	51.8	50.4	46.3
Residual variance	8,152.40 (146.06)	8,075.24 (147.31)	8,078.05 (151.30)
Total unexplained variance	8,709.92	8,614.23	8,605.92
% of unexplained variance due to neighbourhoods	3.0	2.8	2.3
% of unexplained variance due to schools	3.4	3.5	3.8
Bayesian DIC (smaller is better)	112,047	111,946	111,942

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ [NS] Random effect not statistically significant

[1] Covariates include school year and language spoken in the home (data not shown)

Appendix IX Longitudinal analyses of cognitive test performance – full tables

Table 11-17 Results of cross-classified multilevel models predicting reading test performance at age 7, longitudinal analysis (N= 6,524)

	Estimate (Standard Deviation)[1]				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)					
England – disadvantaged	1.92 (3.38)	6.44 (3.57)*	6.38 (3.57)*	6.85 (3.57)*	6.83 (3.57)*
England – ethnic	19.91 (6.25)**	21.87 (6.31)***	21.77 (6.35)***	24.54 (6.31)***	24.50 (6.36)***
Wales – advantaged	-22.12 (5.80)***	-18.05 (5.85)**	-18.21 (5.89)**	-18.00 (5.86)**	-18.17 (5.90)**
Wales – disadvantaged	-35.15 (4.52)***	-27.21 (4.73)***	-27.18 (4.75)***	-27.22 (4.74)***	-27.20 (4.76)***
Scotland – advantaged	-2.43 (5.24)	8.98 (6.17)	8.78 (6.17)	7.95 (6.17)	7.79 (6.17)
Scotland – disadvantaged	-5.02 (5.56)	8.20 (6.20)	8.06 (6.21)	7.27 (6.20)	7.19 (6.22)
NI – advantaged	-25.27 (5.84)***	-12.56 (7.01)*	-12.86 (7.03)*	-13.66 (7.02)*	-13.91 (7.03)*
NI – disadvantaged	-27.49 (5.42)***	-10.49 (6.19)*	-10.79 (6.27)*	-12.10 (6.19)*	-12.39 (6.27)*
Girl	11.37 (2.17)***	11.38 (2.17)***	11.34 (2.18)***	11.27 (2.17)***	11.24 (2.18)***
Child age in months	-2.45 (0.39)***	-2.54 (0.39)***	-2.54 (0.39)***	-2.48 (0.39)***	-2.48 (0.39)***
Has SEN statement	-78.77 (4.43)***	-78.94 (4.43)***	-78.78 (4.45)***	-78.78 (4.43)***	-78.67 (4.45)***
Weekly family income per £100	3.62 (0.66)***	2.54 (0.68)***	2.46 (0.68)***	2.41 (0.68)***	2.34 (0.68)***
NS-SEC (ref= manag. / prof.)					
Intermediate	-11.71 (3.63)**	-10.86 (3.65)**	-10.94 (3.63)**	-10.66 (3.65)**	-10.74 (3.63)**
Small empl. / self empl.	-11.32 (4.24)**	-10.57 (4.27)**	-10.58 (4.24)**	-10.04 (4.28)*	-10.04 (4.25)**
Lower supervisory / tech.	-5.75 (5.04)	-4.37 (5.04)	-4.47 (5.01)	-3.78 (5.05)	-3.87 (5.02)
Semi routine / routine	-17.43 (3.90)***	-15.87 (3.92)***	-15.87 (3.91)***	-15.36 (3.94)***	-15.39 (3.93)***
No parent in work	-13.36 (4.46)**	-13.70 (4.45)**	-13.39 (4.43)**	-13.00 (4.46)**	-12.78 (4.44)**
Housing tenure (ref= owner)					
Rented privately	-5.87 (5.88)	-5.25 (5.90)	-5.12 (5.90)	-4.24 (5.91)	-4.18 (5.91)
Social housing	-16.52 (3.74)***	-16.29 (3.77)***	-16.12 (3.78)***	-13.43 (3.79)***	-13.30 (3.81)***
Other	7.81 (8.13)	7.75 (8.19)	7.42 (8.13)	7.50 (8.19)	7.22 (8.13)

Table 11-17 (continued)

	Estimate (Standard Deviation)[1]				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
Maternal age (years)	0.39 (0.22)*	0.26 (0.22)	0.27 (0.22)	0.22 (0.22)	0.23 (0.22)
Maternal NVQ (ref = level 4/5)					
Level 3	-6.78 (3.32)*	-5.34 (3.33)	-5.38 (3.32)	-5.87 (3.33)*	-5.92 (3.33)*
Level 2	-14.20 (2.97)***	-12.94 (2.97)***	-12.98 (2.98)***	-13.01 (2.98)***	-13.05 (2.98)***
Level 1	-27.68 (4.86)***	-25.51 (4.87)***	-25.79 (4.88)***	-25.64 (4.87)***	-25.89 (4.88)***
Overseas only	-28.84 (9.02)**	-28.61 (8.97)**	-28.53 (8.94)**	-28.72 (8.98)**	-28.67 (8.94)**
None	-39.56 (4.95)***	-37.31 (4.94)***	-37.21 (4.93)***	-37.78 (4.94)***	-37.70 (4.93)***
Number of siblings (ref = none)	-7.60 (1.17)***	-8.02 (1.15)***	-8.00 (1.16)***	-7.88 (1.15)***	-7.85 (1.16)***
Family structure (ref = both natural parents)					
Natural mother / other partner	-14.50 (5.83)**	-14.63 (5.81)**	-14.54 (5.86)**	-13.86 (5.82)**	-13.82 (5.87)**
Single mother	-2.30 (3.50)	-3.02 (3.53)	-2.80 (3.52)	-2.68 (3.54)	-2.51 (3.52)
Child ethnicity (ref = White)					
Mixed	6.73 (7.57)	5.16 (7.58)	5.21 (7.52)	6.20 (7.59)	6.25 (7.54)
Indian	27.84 (10.37)**	22.22 (10.36)*	22.63 (10.37)*	23.33 (10.36)*	23.64 (10.38)*
Pakistani	23.27 (10.24)*	22.51 (10.18)*	22.78 (10.27)*	21.79 (10.18)*	21.91 (10.27)*
Bangladeshi	23.27 (17.90)	24.78 (17.84)	25.23 (17.81)	22.39 (17.85)	22.71 (17.81)
Black Caribbean	5.81 (11.59)	3.55 (11.57)	3.55 (11.63)	3.90 (11.57)	3.88 (11.63)
Black African	46.61 (14.04)***	44.64 (13.98)**	44.69 (14.05)**	45.76 (14.02)**	45.83 (14.08)**
Other (incl. Chinese)	16.06 (14.01)	13.01 (14.03)	13.15 (13.97)	13.25 (14.05)	13.33 (13.99)
Rural (ref = urban)		-8.72 (2.99)**	-8.71 (2.96)**	-9.27 (2.97)**	-9.30 (2.94)**
IMD education domain, per decile (ref=most deprived)		0.81 (0.75)	0.83 (0.75)	0.32 (0.75)	0.33 (0.75)
School fees applicable		13.64 (7.39)*	13.48 (7.36)*	12.84 (7.39)*	12.70 (7.36)*

Table 11-17 (continued)

	Estimate (Standard Deviation)[1]				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
Median household income, per £1000		0.81 (0.25)***	0.80 (0.25)***	0.77 (0.25)**	0.77 (0.25)**
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Second		-2.96 (3.31)	-2.79 (3.30)		
Third		-9.28 (3.45)**	-8.99 (3.44)**		
Fourth		0.15 (3.61)	0.51 (3.64)		
Least satisfied		6.06 (4.06)	6.69 (4.08)		
Interviewer observations sweep two (ref = most favourable)					
Second				-0.23 (3.37)	-0.22 (3.36)
Third				-8.48 (3.52)**	-8.37 (3.52)**
Fourth				-7.04 (3.82)*	-6.87 (3.83)*
Least favourable				-8.88 (4.21)*	-8.77 (4.22)*
Maternal psychological distress (ref = none)					
Current (sweep four)			-4.49 (3.12)		-3.88 (3.12)
Past (sweep two and/or sweep three)			0.55 (2.86)		0.98 (2.86)
Persistent (sweeps two, three and four)			-4.16 (3.50)		-3.13 (3.49)
Between neighbourhood variance	45.89 (58.52)[NS]	25.01 (41.89)[NS]	40.08 (51.16)[NS]	24.40 (41.07)[NS]	39.11 (50.30)[NS]
Between school variance	501.13 (101.76)	465.45 (97.81)	455.62 (99.23)	466.16 (98.36)	457.22 (99.86)
Residual variance	7,171.36 (153.00)	7,159.78 (151.11)	7,153.44 (152.31)	7,169.96 (151.37)	7,164.14 (152.47)
Bayesian DIC (smaller is better)	76,858	76,821	76,824	76,830	76,833

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ [NS] Random effect not statistically significant [1] All models additionally adjusted for school year and language spoken in the home (data not shown)

Table 11-18 Results of cross-classified multilevel models predicting maths test performance at age 7, longitudinal analysis (N= 6,524)

	Estimate (Standard Deviation)[1]				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)					
England – disadvantaged	3.46 (3.81)	9.21 (4.05)*	9.16 (4.04)*	9.15 (4.04)*	9.14 (4.03)*
England – ethnic	8.88 (6.78)	12.78 (6.90)*	12.58 (6.94)*	13.28 (6.89)*	13.19 (6.94)*
Wales – advantaged	1.98 (6.71)	3.79 (6.82)	3.57 (6.86)	3.89 (6.82)	3.61 (6.86)
Wales – disadvantaged	-5.69 (5.16)	1.50 (5.45)	1.47 (5.46)	1.13 (5.46)	1.09 (5.46)
Scotland – advantaged	-13.11 (5.90)*	-6.35 (7.01)	-6.70 (7.00)	-6.90 (7.00)	-7.27 (7.00)
Scotland – disadvantaged	-16.11 (6.16)**	-5.30 (6.96)	-5.65 (6.95)	-5.96 (6.95)	-6.25 (6.95)
NI – advantaged	-2.58 (6.92)	5.10 (8.26)	4.66 (8.19)	4.76 (8.26)	4.31 (8.19)
NI – disadvantaged	17.10 (6.39)**	28.97 (7.23)***	28.55 (7.29)***	28.21 (7.23)***	27.75 (7.29)***
Girl	-8.68 (2.23)***	-8.68 (2.23)***	-8.76 (2.24)***	-8.70 (2.23)***	-8.78 (2.24)***
Child age in months	-3.09 (0.40)***	-3.13 (0.40)***	-3.12 (0.40)***	-3.10 (0.40)***	-3.09 (0.40)***
Has SEN statement	-64.98 (4.55)***	-65.01 (4.56)***	-64.63 (4.58)***	-65.16 (4.56)***	-64.78 (4.58)***
Weekly family income per £100	3.46 (0.68)***	2.73 (0.70)***	2.59 (0.70)***	2.70 (0.71)***	2.57 (0.71)***
NS-SEC (ref= manag. / prof.)					
Intermediate	-9.64 (3.73)**	-9.08 (3.75)**	-9.17 (3.72)**	-8.97 (3.75)**	-9.07 (3.72)**
Small empl. / self empl.	-11.61 (4.34)**	-11.23 (4.38)**	-11.34 (4.34)**	-11.06 (4.38)**	-11.18 (4.35)**
Lower supervisory / tech.	-9.14 (5.18)*	-7.89 (5.17)*	-8.00 (5.15)*	-7.84 (5.18)*	-7.97 (5.16)*
Semi routine / routine	-18.93 (4.00)***	-17.70 (4.04)***	-17.63 (4.02)***	-17.81 (4.05)***	-17.77 (4.04)***
No parent in work	-12.63 (4.59)**	-12.68 (4.60)**	-12.06 (4.56)**	-12.61 (4.61)**	-12.02 (4.57)**
Housing tenure (ref= owner)					
Rented privately	-1.50 (6.06)	-1.41 (6.10)	-1.03 (6.09)	-1.21 (6.11)	-0.89 (6.10)
Social housing	-14.03 (3.90)***	-12.94 (3.92)***	-12.51 (3.94)**	-12.34 (3.94)**	-11.86 (3.97)**
Other	12.47 (8.35)	12.10 (8.43)	11.65 (8.38)	11.66 (8.42)	11.27 (8.37)

Table 11-18 (continued)

	Estimate (Standard Deviation)[1]				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
Maternal age (years)	-0.14 (0.23)	-0.26 (0.23)	-0.24 (0.23)	-0.26 (0.23)	-0.25 (0.23)
Maternal NVQ (ref = level 4/5)					
Level 3	-7.42 (3.41)*	-6.41 (3.43)*	-6.46 (3.43)*	-6.61 (3.43)*	-6.67 (3.43)
Level 2	-14.31 (3.06)***	-13.22 (3.07)***	-13.31 (3.07)***	-13.25 (3.07)***	-13.34 (3.07)
Level 1	-25.80 (4.98)***	-24.15 (5.01)***	-24.61 (5.01)***	-24.29 (5.01)***	-24.76 (5.01)
Overseas only	-27.45 (9.25)**	-27.10 (9.25)**	-26.79 (9.20)**	-27.15 (9.25)**	-26.85 (9.21)
None	-30.43 (5.09)***	-28.63 (5.08)***	-28.56 (5.08)***	-29.08 (5.08)***	-29.05 (5.08)
Number of siblings (ref = none)	-1.17 (1.20)	-1.43 (1.19)	-1.42 (1.20)	-1.43 (1.19)	-1.41 (1.20)
Family structure (ref = both natural parents)					
Natural mother / other partner	-5.06 (5.99)	-4.95 (5.99)	-4.66 (6.02)	-5.10 (6.00)	-4.78 (6.03)
Single mother	1.02 (3.59)	0.82 (3.64)	1.21 (3.61)	0.88 (3.64)	1.26 (3.62)
Child ethnicity (ref = White)					
Mixed	1.44 (7.82)	0.93 (7.83)	1.04 (7.80)	1.14 (7.84)	1.27 (7.81)
Indian	10.76 (10.90)	8.22 (10.90)	8.90 (10.93)	8.91 (10.90)	9.47 (10.94)
Pakistani	-24.25 (10.87)*	-23.47 (10.85)*	-22.81 (10.94)*	-23.96 (10.84)*	-23.46 (10.93)*
Bangladeshi	-38.45 (18.52)*	-35.96 (18.52)*	-35.45 (18.49)*	-36.83 (18.52)*	-36.44 (18.49)*
Black Caribbean	-4.33 (12.24)	-5.45 (12.24)	-5.13 (12.30)	-5.33 (12.23)	-4.97 (12.29)
Black African	-9.50 (14.79)	-9.39 (14.72)	-9.44 (14.80)	-10.47 (14.75)	-10.51 (14.83)
Other (incl. Chinese)	-6.38 (14.48)	-7.61 (14.53)	-7.45 (14.47)	-7.93 (14.54)	-7.82 (14.48)
Rural (ref = urban)		-1.37 (3.45)	-1.32 (3.42)	-0.92 (3.43)	-0.96 (3.40)
IMD education domain, per decile (ref=most deprived)		0.99 (0.84)	1.00 (0.83)	0.99 (0.84)	0.97 (0.83)
School fees applicable		6.85 (7.85)	6.61 (7.84)	6.27 (7.85)	6.09 (7.84)

Table 11-18 (continued)

	Estimate (Standard Deviation)[1]				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
Median household income, per £1000		0.57 (0.28)*	0.57 (0.28)*	0.56 (0.28)*	0.56 (0.28)*
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Second		-1.10 (3.41)	-0.78 (3.41)		
Third		-6.90 (3.56)*	-6.31 (3.56)*		
Fourth		-2.97 (3.75)	-2.28 (3.77)		
Least satisfied		1.33 (4.19)	2.57 (4.21)		
Interviewer observations sweep two (ref = most favourable)					
Second				1.37 (3.47)	1.44 (3.47)
Third				-3.83 (3.64)	-3.54 (3.64)
Fourth				-3.76 (3.98)	-3.29 (3.98)
Least favourable				1.05 (4.40)	1.33 (4.41)
Maternal psychological distress (ref = none)					
Current (sweep four)			-5.67 (3.20)*		-5.50 (3.20)*
Past (sweep two and/or sweep three)			-0.90 (2.94)		-0.82 (2.94)
Persistent (sweeps two, three and four)			-8.94 (3.60)		-8.57 (3.58)
Between neighbourhood variance	678.01 (133.51)	650.63 (131.67)	658.31 (137.96)	650.87 (131.55)	658.39 (137.78)
Between school variance	862.36 (134.90)	855.53 (135.00)	849.56 (132.50)	851.69 (134.85)	845.91 (132.44)
Residual variance	6,887.59 (161.44)	6,889.52 (162.46)	6,881.75 (163.13)	6,894.83 (162.59)	6,887.66 (163.25)
Bayesian DIC (smaller is better)	77,123	77,117	77,114	77,120	77,118

*** $p < 0.001$ ** $p < 0.01$ *$p < 0.05$ [1] All models additionally adjusted for school year and language spoken in the home (data not shown)

Table 11-19 Results of cross-classified multilevel models predicting pattern construction test performance at age 7, longitudinal analysis (N= 6,524)

	Estimate (Standard Deviation)[1]				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
MCS stratum (ref = England - advantaged)					
England – disadvantaged	-9.01 (3.48)	-2.92 (3.70)	-3.02 (3.68)	-2.89 (3.70)	-2.95 (3.68)
England – ethnic	-9.11 (6.54)	-4.91 (6.63)	-5.07 (6.66)	-5.03 (6.62)	-5.09 (6.65)
Wales – advantaged	7.61 (5.92)	7.61 (6.03)	7.54 (6.03)	7.98 (6.04)	7.85 (6.04)
Wales – disadvantaged	-1.84 (4.66)	4.83 (4.91)	4.81 (4.92)	4.44 (4.93)	4.41 (4.93)
Scotland – advantaged	5.66 (5.29)	9.41 (6.33)	9.01 (6.30)	9.27 (6.33)	8.85 (6.31)
Scotland – disadvantaged	-17.05 (5.67)**	-7.72 (6.40)	-8.15 (6.37)	-8.15 (6.40)	-8.52 (6.38)
NI – advantaged	9.48 (6.19)	13.51 (7.45)*	13.13 (7.42)*	13.58 (7.46)*	13.19 (7.43)*
NI – disadvantaged	-1.12 (5.71)	9.26 (6.53)	9.02 (6.58)	9.21 (6.53)	8.92 (6.58)
Girl	5.99 (2.28)**	5.92 (2.28)**	5.82 (2.29)**	5.99 (2.28)**	5.90 (2.29)**
Child age in months	0.69 (0.41)*	0.66 (0.41)	0.67 (0.41)	0.67 (0.41)	0.69 (0.41)*
Has SEN statement	-46.42 (4.65)***	-46.49 (4.66)***	-46.12 (4.68)***	-46.50 (4.65)***	-46.12 (4.68)***
Weekly family income per £100	1.95 (0.69)**	1.16 (0.72)	1.06 (0.72)	1.11 (0.72)	1.01 (0.72)
NS-SEC (ref= manag. / prof.)					
Intermediate	-11.61 (3.82)**	-10.72 (3.85)**	-10.76 (3.82)**	-10.74 (3.85)**	-10.80 (3.82)**
Small empl. / self empl.	-8.89 (4.46)*	-7.99 (4.50)*	-8.15 (4.47)*	-7.80 (4.50)*	-7.97 (4.47)*
Lower supervisory / tech.	-1.09 (5.30)	0.54 (5.31)	0.41 (5.28)	0.67 (5.31)	0.53 (5.29)
Semi routine / routine	-16.18 (4.10)***	-14.22 (4.14)***	-14.08 (4.13)***	-14.40 (4.15)***	-14.28 (4.14)***
No parent in work	-12.58 (4.68)**	-12.12 (4.69)**	-11.60 (4.66)**	-12.22 (4.70)**	-11.73 (4.67)**
Housing tenure (ref= owner)					
Rented privately	0.89 (6.19)	1.24 (6.21)	1.58 (6.20)	1.28 (6.22)	1.60 (6.21)
Social housing	-11.17 (3.94)**	-9.20 (3.96)*	-8.78 (3.99)*	-9.20 (3.98)*	-8.72 (4.01)*
Other	4.21 (8.56)	3.72 (8.62)	3.57 (8.57)	3.16 (8.62)	3.04 (8.56)

Table 11-19 (continued)

	Estimate (Standard Deviation)[1]				
	Model A	**Model B**	**Model C**	**Model D**	**Model E**
Maternal age (years)	0.01 (0.23)	-0.14 (0.23)	-0.13 (0.23)	-0.15 (0.24)	-0.14 (0.24)
Maternal NVQ (ref = level 4/5)					
Level 3	-7.08 (3.49)*	-5.76 (3.51)	-5.86 (3.51)*	-5.81 (3.51)*	-5.93 (3.51)*
Level 2	-13.28 (3.12)***	-11.64 (3.13)***	-11.76 (3.13)***	-11.71 (3.13)***	-11.82 (3.13)***
Level 1	-23.31 (5.11)***	-20.95 (5.14)***	-21.25 (5.14)***	-21.05 (5.14)***	-21.37 (5.14)***
Overseas only	-34.99 (9.48)***	-34.99 (9.46)***	-34.78 (9.42)***	-34.81 (9.46)***	-34.59 (9.42)***
None	-29.15 (5.20)***	-26.72 (5.20)***	-26.66 (5.19)***	-26.89 (5.20)***	-26.87 (5.19)***
Number of siblings (ref = none)	-0.62 (1.22)	-0.86 (1.21)	-0.85 (1.22)	-0.89 (1.22)	-0.88 (1.22)
Family structure (ref = both natural parents)					
Natural mother / other partner	-2.73 (6.13)	-2.34 (6.12)	-1.78 (6.17)	-2.73 (6.13)	-2.14 (6.18)
Single mother	-3.92 (3.68)	-3.99 (3.72)	-3.66 (3.71)	-4.02 (3.72)	-3.68 (3.71)
Child ethnicity (ref = White)					
Mixed	-11.35 (7.95)	-12.08 (7.98)	-12.00 (7.92)	-11.76 (7.98)	-11.67 (7.93)
Indian	-6.85 (10.86)	-9.94 (10.86)	-9.41 (10.89)	-9.22 (10.87)	-8.76 (10.89)
Pakistani	-42.40 (10.71)***	-41.95 (10.68)***	-41.13 (10.77)***	-42.22 (10.68)***	-41.51 (10.77)***
Bangladeshi	-11.29 (18.72)	-9.03 (18.74)	-8.50 (18.67)	-9.55 (18.73)	-9.11 (18.67)
Black Caribbean	-49.94 (12.20)***	-51.91 (12.19)***	-51.38 (12.25)***	-51.65 (12.18)***	-51.08 (12.25)***
Black African	-54.07 (14.78)***	-54.38 (14.72)***	-54.64 (14.79)***	-55.49 (14.75)***	-55.75 (14.81)***
Other (incl. Chinese)	-10.10 (14.73)	-12.39 (14.76)	-11.79 (14.72)	-12.45 (14.77)	-11.88 (14.73)
Rural (ref = urban)		-4.69 (3.11)	-4.71 (3.07)	-4.03 (3.09)	-4.13 (3.05)
Median household income, per £1000		0.37 (0.26)	0.37 (0.26)	0.37 (0.26)	0.37 (0.26)
School fees applicable		1.86 (7.71)	1.80 (7.65)	1.36 (7.70)	1.34 (7.66)

Table 11-19 (continued)

	Estimate (Standard Deviation)[1]				
	Model A	Model B	Model C	Model D	Model E
IMD education domain, per decile (ref=most deprived)		1.93 (0.78)**	1.93 (0.78)**	2.03 (0.78)**	2.03 (0.78)**
Neighbourhood satisfaction sweep two (ref = most satisfied)					
Second		-4.87 (3.48)	-4.66 (3.48)		
Third		-5.40 (3.63)	-5.01 (3.62)		
Fourth		-7.06 (3.81)*	-6.53 (3.83)*		
Least satisfied		-2.41 (4.26)	-1.38 (4.29)		
Interviewer observations sweep two (ref = most favourable)					
Second				-1.35 (3.54)	-1.21 (3.53)
Third				-4.11 (3.70)	-3.89 (3.70)
Fourth				-6.11 (4.02)	-5.75 (4.03)
Least favourable				0.94 (4.42)	1.23 (4.43)
Maternal psychological distress (ref = none)					
Current (sweep four)			-4.50 (3.29)		-4.48 (3.28)
Past (sweep two and/or sweep three)			-4.34 (3.01)		-4.33 (3.01)
Persistent (sweeps two, three and four)			-6.57 (3.68)*		-6.40 (3.66)*
Between neighbourhood variance	287.19 (119.50)	263.32 (102.60)	281.51 (111.91)	264.10 (102.86)	281.56 (112.04)
Between school variance	198.99 (105.77)	188.09 (97.02)	153.72 (109.53)	193.69 (97.61)	161.71 (109.64)
Residual variance	7,994.17 (175.71)	7,990.27 (179.94)	8,004.16 (181.37)	7,983.99 (179.77)	7,996.33 (181.51)
Bayesian DIC (smaller is better)	77,517	77,501	77,504	77,499	77,503

*** p < 0.001 ** p < 0.01 *p < 0.05 [1] All models additionally adjusted for school year and language spoken in the home (data not shown)